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DELPHON INDUSTRIES, LLC dba GEL-PAK

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

[DIVISION TO BE ASSIGNED]

DELPHON INDUSTRIES, LLC dba GEL-PAK, a Delaware limited liability company,

Plaintiff,

v.

INTERNATIONAL TEST SOLUTIONS, INC., a Nevada corporation; INTERNATIONAL TEST SOLUTIONS, INC., a California corporation; JOYCE FREEZE, an individual; and ALAN E. HUMPHREY, an individual,

Defendants.

CV 11-01338

Case Number:

PLAINTIFF'S COMPLAINT FOR:

1. **BREACH OF CONTRACT;**
2. **BREACH OF THE IMPLIED COVENANT OF GOOD FAITH AND FAIR DEALING;**
3. **WILLFUL TRADE SECRET MISAPPROPRIATION;**
4. **STATUTORY UNFAIR COMPETITION;**
5. **CORRECTION OF INVENTORSHP**
6. **DECLARATORY RELIEF – CONTRACTUAL OWNERSHIP**

AND

DEMAND FOR JURY TRIAL

Plaintiff DELPHON INDUSTRIES, LLC dba GEL-PAK, by its undersigned counsel, hereby brings this action against defendants INTERNATIONAL TEST SOLUTIONS, INC. (a Nevada corporation), INTERNATIONAL TEST SOLUTIONS, INC. (a California corporation), JOYCE FREEZE, and ALAN E. HUMPHREY (collectively, the "Defendants"), and alleges as follows:

THE PARTIES

1. Delphon Industries, LLC is a limited liability company organized and existing under the laws of the State of Delaware, doing business as Gel-Pak and having its principal place of business at 31398 Huntwood Avenue, Hayward, CA 94544. Delphon Industries, LLC dba Gel-Pak is the successor-in-interest to Gel-Pak, LLC, and shall simply be referred to in this Complaint as "Gel-Pak" or "Plaintiff."

2. Defendant International Test Solutions , Inc. ("ITS California") was a corporation that was organized and existed under the laws of California, having its principal place of business at 2479 Chardonnay Way, Livermore, CA 94550. On information and belief, Defendant ITS California was originally formed as a corporation in California on or about May 11, 1999, was dissolved as a California corporation on or about February 4, 2008, and no longer is in existence.

3. Defendant International Test Solutions, Inc. ("ITS Nevada"), is organized and existing as a corporation under the laws of Nevada, having its principal place of business at 1595 Meadow Wood Lane, Reno, NV 89502. On information and belief, ITS Nevada was originally formed as a corporation in Nevada on or about October 22, 1998, and remains an existing corporation under Nevada law as of the date of the filing of this Complaint. On information and belief, Defendant ITS California and Defendant ITS Nevada have shared the same name (i.e., "International Test Solutions"), directors, officers, employees, managing agents, customers and suppliers and have been jointly controlled and operated, and have engaged in the same business throughout their existence. On further information and belief, Defendant ITS Nevada is the alter ego, successor and/or assign of Defendant ITS California.

4. Gel-Pak alleges that Defendant Joyce Freeze, also known as Billie Jean Freeze, Billie Joyce Freeze, Billie J. Freeze, and Joyce Adams ("Freeze"), is an individual residing in or around Reno, Nevada. At all times relevant to this Complaint, Freeze was the CEO of Defendant ITS California and, along with others, had responsibility as a managing agent of Defendant ITS California to manage and supervise its business operations, business relationships and dealings, and personnel. On information and belief, Freeze also serves as the CEO, Secretary, and Treasurer of

Defendant ITS Nevada and, along with others, has responsibility as a managing agent of Defendant ITS Nevada to manage and supervise its business operations, business relationships and dealings, and personnel.

5. Gel-Pak alleges that Defendant Alan E. Humphrey, also known as Gene Humphrey ("Humphrey"), is an individual residing in or around Reno, Nevada. At all times relevant to this Complaint, Humphrey was the President and COO of Defendant ITS California and, along with others, had responsibility as a managing agent of Defendant ITS California to manage and supervise its business operations, business relationships and dealings, and personnel. On information and belief, Humphrey is also the President, COO, and a Director of Defendant ITS Nevada and, along with others, has responsibility as a managing agent of Defendant ITS Nevada to manage and supervise its business operations, business relationships and dealings, and personnel.

6. On information and belief, Humphrey and Freeze were together the controlling shareholders of Defendant ITS California and Defendant ITS Nevada at all times relevant herein.

7. Gel-Pak is informed and believes, and on that basis alleges, that in doing the acts alleged herein, each Defendant was acting as the agent, servant, or employee of each of the other Defendants, and in doing the things hereinafter alleged was acting within the scope of his/her/its authority as an agent, servant, or employee, and with the permission and consent, of each of the other Defendants. Gel-Pak further alleges that, to the extent any Defendant was a shareholder of Defendant ITS California to whom the assets of Defendant ITS California were distributed, or a distribution was made to such Defendant not for equivalent value, such Defendant is further subject to liability under the California Corporations Code Section and California Civil Code for the wrongful and unlawful acts alleged in this Complaint.

8. Gel-Pak is informed and believes, and on that basis alleges, that there exists, and at all relevant times herein alleged that there existed, a unity of interest and ownership between Defendant ITS California, on the one hand, and Defendants Freeze, Humphrey, and ITS Nevada on the other hand, such that any individuality and/or separateness between Defendant ITS California and the Defendants does not exist, and Defendants were and are the *alter ego* of the Defendant ITS

California, in that: (1) Defendant ITS California and ITS Nevada used the identical name to conduct business and related transactions, causing confusion and deception to Plaintiff and others; (2) Defendant ITS California and Defendants ITS Nevada, Freeze and Humphrey used the same employees, customers, vendors, offices and business location; (3) Defendants Freeze, Humphrey and ITS Nevada dominated and controlled Defendant ITS California; (4) Defendants Freeze, Humphrey and ITS Nevada abused the corporate form of Defendant ITS California, and did not operate the corporation or its business in good faith or with appropriate observance of corporate laws and regulations; (5) Defendant ITS Nevada and Defendant ITS California each ordered goods, directed shipment and made payments to Gel-Pak pursuant to the Distribution Agreement (described below) as though they were one and the same company and were interchangeable; (6) Defendants Freeze, Humphrey and ITS Nevada, created and used Defendant ITS California as a mere shell, instrumentality, or conduit for a single venture or the business of Defendants Freeze, Humphrey and ITS Nevada, and as a mechanism to shield themselves from individual liability for their wrongful conduct alleged herein; and (7) Defendants Freeze, Humphrey and ITS Nevada created Defendant ITS California and used Defendant ITS California with the intent to subsequently dissolve it and disavow responsibility for actions taken or obligations incurred while doing business as Defendant ITS California. On further information and belief, adherence to the fiction of the separate existence of Defendant ITS California as an entity distinct from Defendants Freeze, Humphrey and ITS Nevada would permit an abuse of the corporate privilege and corporate protections, sanction fraud, and promote injustice, in that it would allow those Defendants to avoid liability for the wrongful conduct alleged herein and prevent attachment and execution by judgment creditors, including Gel-Pak, by deliberately rendering Defendant ITS California insolvent or dissolved and unable to meet (or functionally exempt from meeting) its obligations.

9. Gel-Pak is informed and believes, and on that basis alleges, that each of the Defendants conspired with the other Defendants to do the acts alleged in this Complaint.

JURISDICTION AND VENUE

10. This Court has jurisdiction over this action under the Patent Laws of the United

States pursuant to 35 U.S.C. §§256 and 285, et seq. Subject matter jurisdiction is conferred pursuant to 28 U.S.C. § 1331 and 1338(a). This Court has jurisdiction over Plaintiff's related claims based on State Law pursuant to 28 U.S.C. § 1367.

11. This Court has personal jurisdiction over all Defendants in this action as Defendants have engaged in substantial business within this forum amounting to sufficient minimum contacts including, but not limited to, soliciting and entering into agreements with Gel-Pak and others in this judicial district, jointly developing New Products (described herein) with Gel-Pak in Gel-Pak's laboratories located in this judicial district, distributing, marketing, using, selling, and/or offering to sell products and services in California and this judicial district that are part of the subject matter of this Complaint, and employing and/or directing personnel (or acting themselves) within this judicial district as a function of the business dealings of Defendant ITS Nevada.

12. Venue is proper in this judicial district pursuant to 28 U.S.C. 1391(a) as (1) the Defendants are subject to personal jurisdiction in this district; and (2) a substantial part of the events or omissions giving rise to the claim occurred here.

13. Intradistrict Assignment. Pursuant to Northern District of California, Civil Local Rule 3-2(c), this matter shall be assigned to a division of the Northern District on a district-wide basis as it deals with the ownership of intellectual property.

FACTUAL BACKGROUND

TECHNOLOGIES AND PRODUCTS OF THE PARTIES

14. Gel-Pak has been creating and manufacturing innovative solutions for the safe shipping and handling of delicate technological devices as its primary business since 1980. Gel-Pak's principal products enable the safe and protected shipping, handling, storage, inspection, testing, assembly, backgrinding, and lapping of valuable technological devices that would otherwise be susceptible to potential damage or degradation, either for transportation between laboratories or during processes performed within laboratories.

15. Gel-Pak's unique and proprietary gels ("Gels") are the key component in Gel-Pak's

products. The Gels are a tacky and viscous substance that allows Gel-Pak's products to perform the functions for which they are used, such as holding delicate devices in place within Gel-Pak's containers and carriers. The Gels are polymers created using Gel-Pak's proprietary formulas, which consist of precise mixtures, blends, and balances of specific chemical elements. Gel-Pak has developed several gel formulas for specific applications and uses.

16. Gel-Pak's proprietary Gel formulas and manufacturing processes were developed as the result of the company's investment of significant time, intellect, energy, and resources into testing potential chemical compound formulas and their properties over many years. Gel-Pak's proprietary Gel formulas are "secret recipes," the confidentiality of which provides substantial value to Gel-Pak and an important competitive advantage. The precise chemical blends and manufacturing processes of Gel-Pak's Gels have always been kept highly confidential and proprietary to Gel-Pak as trade secrets. Gel-Pak has taken all reasonable steps necessary to protect the confidential interest of its trade secrets.

17. Additionally, the specific manufacturing processes by which Gel-Pak mixes and creates its Gels and applies the Gels to substrates are also highly confidential and proprietary trade secrets that provide the company with a competitive advantage. Like Gel-Pak's proprietary Gel formulas, Gel-Pak's proprietary manufacturing processes were developed through intensive trial-and-error methods, and are the result of Gel-Pak's investment of significant time, intellect, energy, and resources in testing and refining its start-to-finish mixing and application manufacturing processes over many years.

DISTRIBUTION AGREEMENT BETWEEN THE PARTIES

18. Prior to 1999, Gel-Pak had developed numerous products that incorporated its proprietary Gel, which could in certain applications be used for the purpose of cleaning test probe tips used in the semiconductor manufacturing process. Automated testing is part of the typical semiconductor manufacturing process. The process generally involves sets of probes ("test probes") that test semiconductor circuits and functions. Gel-Pak's Gels were utilized as probe cleaning products by placing the Gel (*e.g.*, such as a film of gel) on substrates, introducing them into

semiconductor wafer processing machines, and bringing the Gel into contact with the tips of test probes which may have become contaminated with debris in order to clean the tips of the test probes. When the Gel is placed into contact with the test probes, the tackiness of the Gel functions to remove and clean contaminants from the probe tips.

19. In 1999, Defendants approached Gel-Pak and proposed entering into a development and distribution agreement related to the Gel films that Gel-Pak was already manufacturing and marketing for applications as probe cleaning products. When Defendants approached Gel-Pak, they claimed to have intimate knowledge of the probe cleaning product market. Defendants proposed to Gel-Pak that the parties enter into an agreement whereby Gel-Pak would provide its proprietary Gel, manufacturing expertise and existing probe cleaning products to Defendants for the purpose of selling products to the probe cleaning market. Defendants represented that both Gel-Pak and Defendants would benefit from the arrangement, in that Gel-Pak's sales volume of its products would increase substantially because Defendants were purportedly more knowledgeable regarding the needs of the relevant market, and Defendants would reap profits from developing and expanding the probe cleaning market and from price mark-ups on the products.

20. Defendants also proposed the development of new products that would be innovative extensions or derivatives of Gel-Pak's existing products. Defendants suggested combining Gel-Pak's proprietary Gel with additional elements or substrates to create new products. Defendants proposed that Gel-Pak and Defendants jointly develop these new products, represented that Defendants would sell them to the relevant market they purportedly knew very well, and promised that Gel-Pak would receive income both from the sale of gel materials to Defendants and from royalties on the sale by Defendants of the new products incorporating those materials.

21. Prior to the execution of an agreement, Defendants made numerous representations to Gel-Pak regarding the tremendous size of the market Defendants had purportedly identified for both the existing Gel-Pak products and the new probe cleaning products. Defendants represented to Gel-Pak that gross revenue from the probe cleaning products would be at least $3-5 million per year and would likely exceed $50 million total within a matter of a few years. Gel-Pak believed and

justifiably relied on Defendants representations. During the course of the discussions and negotiations leading up to the execution of the agreement, Defendants never informed Gel-Pak, and Gel-Pak did not know, that Defendants had actually formed two corporations in two different states with the identical name, i.e., "International Test Solutions" and that Defendants were conducting business interchangeably between the corporations and among the Defendants.

22. In justifiable reliance on Defendants' representations, Gel-Pak executed a Distribution Agreement with Defendants effective as of October 1, 1999, a true and correct copy of which is attached hereto as **Exhibit A,** and incorporated herein by this reference. Under the Distribution Agreement, the products Gel-Pak was already making are defined as the "Existing Products." The new products Gel-Pak and Defendants intended to jointly develop are defined as the "New Products." Both the Existing Products and the New Products are defined together as the "Test Products." Gel-Pak and Defendants also executed a prior, separate non-disclosure agreement ("NDA"), a true and correct copy of which is attached hereto as **Exhibit B**, an incorporated herein by this reference.

DEVELOPMENT OF PRODUCTS

23. Following the execution of the Distribution Agreement, Gel-Pak began working diligently to fulfill its obligations. Subject to the written confidentiality obligations that were in place, Gel-Pak granted Defendants extraordinary and unprecedented access to Gel-Pak's laboratories, staff, proprietary information and processes in order to teach Defendants what was necessary to effectively market and sell the Test Products, and in order to jointly develop the New Products. Gel-Pak's materials scientists, including in particular its Director of Materials and Technology, Claudia Allison, devoted a significant portion of their time, energy, and resources over a period of no less than approximately two years to developing, testing, perfecting, and establishing manufacturing processes for the New Products, all without charge to Defendants. Defendants were provided access to the entire manufacturing process of measuring and mixing Gel-Pak's proprietary Gels, so that Defendants were privy to the elements used by Gel-Pak and the quantities and blends as well as the techniques, equipment and methods used to manufacture its gels. All of this

information was provided at the specific request of Defendants pursuant to the Distribution Agreement and NDA.

24. Early in the course of its dealings with Gel-Pak, Defendants sought to sell both Existing Products and New Products to Intel Corporation. However, Intel had extensive qualification requirements, and would not deal with Defendants alone because they had not previously provided products to Intel. In or about August of 2000, Intel required, as a condition precedent to doing business with Defendants, that Gel-Pak submit to an audit of Gel-Pak's entire process of manufacturing the Gel and related products, as a means of assuring Intel that Defendants would be able to deliver on what it was selling to Intel. Because it was necessary in order for Defendants to consummate the sale of products to an important customer (i.e., Intel) under the Distribution Agreement, and because the Distribution Agreement and NDA required Defendants to maintain the confidentiality of Gel-Pak's trade secrets, Gel-Pak allowed Defendants to participate in the audit and to have access to Gel-Pak's proprietary and trade secret technologies. As a further protection for Gel-Pak, the audit was conducted subject to a separate nondisclosure agreement (the "Intel/ITS NDA"), executed by Intel, Defendants, and Gel-Pak, a true and correct copy of which is attached hereto as **Exhibit C,** and incorporated herein by this reference.

25. At all times, Gel-Pak has diligently adhered to measures reasonable under the circumstances to protect the secrecy and confidentiality of its proprietary and trade secret information. Gel-Pak's efforts include requiring a confidentiality and nondisclosure provision to be included in the Distribution Agreement attached hereto as **Exhibit A**, requiring the execution of the nondisclosure agreements attached hereto as **Exhibits B-C**, routinely requiring its employees to sign confidentiality and nondisclosure agreements, securing its laboratories and restricting access thereto, requiring visitors to the laboratories to sign confidentiality and nondisclosure agreements, restricting access to certain types of information and documents to only the specific employees with a business need to know the information, and designating information and materials with labels of confidentiality or otherwise removing them from plain view even within Gel-Pak's laboratory.

26. Ultimately, Gel-Pak and Defendants were able to successfully develop the New

Products known as Probe Scrub and Probe Polish. Accordingly, Defendants were obligated under the Distribution Agreement to aggressively market and sell the Test Products.

SALES OF THE PRODUCTS

27. Defendants' purported sales of Test Products have never amounted to anything near the levels projected and promised by Defendants prior to the execution of the Distribution Agreement.

28. As to the Existing Products (*i.e.*, Probe Clean), Gel-Pak has refrained from actively soliciting its own sales of those products, and has referred potential sales and leads regarding those products to Defendants. Gel-Pak has supplied Defendants with whatever amounts of the products they ordered. Gel-Pak has fulfilled its responsibilities under the Distribution Agreement with respect to the Existing Products. In fact, Defendants' orders of Existing Products have steadily dwindled over the years the Distribution Agreement has been in place. Gel-Pak has followed up regularly with Defendants throughout the years since the execution of the Distribution Agreement, but has been told by Defendants that the market for simply is not as robust as originally projected, and that only a small amount of sales of Existing Products have been made. Because Gel-Pak believed Defendants' representations that they would buy all Existing Products from Gel-Pak, there was not a reason for Gel-Pak to question Defendants' representations regarding the amount of sales.

29. Subsequently, Gel-Pak employee Darby Davis visited a Gel-Pak client in Taiwan. While present in the client's offices, Mr. Davis noticed what appeared to be a quantity of the Probe Clean product. Gel-Pak's client explained that it purchases all of its Probe Clean products directly from Defendants, and had been purchasing approximately $250,000 of the Probe Clean product each year. Defendants had not been ordering such quantities of the Probe Clean product from Gel-Pak in recent years, and had represented to Gel-Pak they have not been selling anything like such quantities of the Probe Clean product in recent years.

30. Based on testing of the Probe Clean product currently being sold by Defendants without Gel-Pak's involvement, Gel-Pak has determined in or about the Spring 2009, that Defendants, without the knowledge or consent of Gel-Pak, had been manufacturing (or having a

third party manufacture) and selling products that are functionally equivalent to the products they agreed to distribute and sell on behalf of Gel-Pak. Defendants therefore deliberately breached the Distribution Agreement and the NDA and the Intel/ITS NDA and deprived Gel-Pak of the benefit of Gel-Pak's bargain with Defendants, by manufacturing and selling products that directly compete with the Gel-Pak products Defendants were contractually obligated to actively and aggressively promote and sell throughout the world. The Probe Clean product sold without Gel-Pak's involvement is either an unlawful and unfair substitute for the Existing Product that Defendants are obligated under the Distribution Agreement to obtain from Gel-Pak and aggressively promote and sell throughout the world, or it is a New Product governed by Sections 3.3 and 8.1 of the Distribution Agreement that Defendants should have given Gel-Pak the opportunity to supply, and for which Defendants should, in any event, be paying royalties to Gel-Pak based on the gross revenues received from sales of the product.

31. As to the functioning New Products explicitly named in the Distribution Agreement (*i.e.*, Probe Scrub and Probe Polish), Gel-Pak diligently developed the products proposed by Defendants, has supplied all such products ordered by Defendants in accordance with the Distribution Agreement. Thus, Gel-Pak has complied with its obligations to Defendants with respect to the New Products. However, Defendants (through Freeze and Humphrey) have continually represented to Gel-Pak that its total gross revenue from sales of those New Products has never exceeded $1,000,000. In response to regular follow-up inquiries by Gel-Pak since the execution of the Distribution Agreement, Defendants (through Freeze and Humphrey) have made written and verbal representations to Gel-Pak regarding the amount of gross revenue received from sales of these products, and its purported gross revenues have always been reported to Gel-Pak as well short of $1,000,000 total. Therefore, Defendants have refused to pay Gel-Pak any royalties, citing Section 8.1 of the Distribution Agreement. Defendants (through at least Freeze and Humphrey) have also made representations to Gel-Pak about the lack of demand for the New Products and the purported shrinking market for the New Products. Again, Freeze specifically represented to Darby Davis of Gel-Pak during a meeting in May of 2007 that the market for probe

cleaning products was very small and was decreasing.

32. In response to direct and persistent inquiries, Defendants have reported supposed sales and gross revenue numbers to Gel-Pak. Based on analysis of the purported sales and gross revenue numbers, it is clear that Defendants (through Freeze and Humphrey) are misrepresenting and underreporting the amount of gross revenue they have reaped from sales of the New Products. Based on information Gel-Pak possesses regarding the raw number of New Product units that Gel-Pak alone has manufactured for Defendants in order to allow them to fill sales orders, and further based on Gel-Pak's knowledge of the substantially marked-up price at which Defendants actually sell the New Product units to consumers, Gel-Pak calculates that Defendants' gross revenue from sales of the New Products has substantially exceeded $1,000,000. Gel-Pak's calculations are soundly based on its own historical sales to Defendants and its knowledge of sales to (and usage by) customers, and do not take into consideration additional sales of New Products manufactured by Defendants or third parties in violation of the Distribution Agreement, about which Gel-Pak may be unaware. For instance, Defendants' underreporting is compounded because the Probe Clean product Gel-Pak has discovered they are selling without Gel-Pak's involvement is considered a New Product governed by Sections 3.3 and 8.1 of the Distribution Agreement.

DEMANDS FOR ACCOUNTING FROM ITS

33. Defendants have never provided Gel-Pak with quarterly demand forecasts with respect to any of the Test Products, as obligated to do under Section 2.4 of the Distribution Agreement. Defendants have also refused requests by Gel-Pak for an accounting of Defendants' sales of, and gross revenues from, the Test Products. The most recent purported sales report summary (not a full accounting) provided by Defendants (through Freeze and Humphrey) was in 2005, in response to persistent demands from Gel-Pak. Since 2005, Defendants have continued to represent to Gel-Pak in the course of several verbal communications (including with Freeze and Humphrey) that gross revenues from sales of the New Products have not reached the $1,000,000 threshold, and has further represented that gross revenues likely never will reach that threshold. The represenatations are false. On information and belief, Gel-Pak has been damaged in an amount of at

least $500,000 resulting from Defendants' conduct.

34. Most recently, Gel-Pak's Vice President and CFO, Jim Bly, sent a letter dated January 29, 2009 directed to Defendant Freeze, noting the apparent discrepancies in Defendants' purported reporting of sales, and demanding a full accounting of sales of Test Products for the entire period of the Distribution Agreement. Defendants responded with a letter from its lawyer dated March 6, 2009, claiming (among other misstatements and incorrect assertions) that they owe Gel-Pak nothing under the Distribution Agreement. Defendants have therefore failed to provide any accounting of past or of current sales of, and gross revenues from, the Test Products, all of which Defendant ITS Nevada continues to advertise for sale on its website at www.inttest.net.

PATENT INVENTORSHIP AND OWNERSHIP

35. In addition to its breaches of the Distribution Agreement, Defendants have failed to properly credit Gel-Pak for the joint development of several patents and/or patent applications. The Distribution Agreement expressly provides that all intellectual property created in the course of developing New Products will be jointly owned. (**Exhibit A**, Section 7.2.) Defendants have named Freeze and/or Humphrey as the inventors of certain patents or patent applications that are based on inventions primarily or entirely of Gel-Pak employees, but contrary to the terms of the Distribution Agreement, Defendants failed to name any Gel-Pak employees as inventors on those patents or patent applications. Gel-Pak has identified at least two U.S. Patents issued to executives or employees of Defendants, and assigned solely to Defendant ITS Nevada, that claim such inventions. These resulting patents, which are based on the inventive input provided by Gel-Pak should rightfully have named at least Gel-Pak's Director of Materials and Technology, Claudia Allison, as a joint inventor on the Patents. The two issued patents are U.S. Patent No. 6,777,966 (a true and correct copy of which is attached as **Exhibit D**) and U.S. Patent No. 7,202,683 (a true and correct copy of which is attached as **Exhibit E**). There is one additional U.S. patent application (U.S. Patent Application No. 11/237,596, published as U.S. Publication No. 2006/0065290) on which Claudia Allison should also be named as a joint inventor, but is not. A true and correct copy of that

patent application bearing U.S. Publication No. 2006/0065290 is attached as **Exhibit F**. These patents and this patent application shall be referred to collectively herein as the "Patents."

36. As described and alleged above, Gel-Pak, through its executives and/or employees, invested a significant degree of time, energy, and expense working with defendants (and often on its own) to develop the technologies embodied by the New Products. In particular, in her capacity as Gel-Pak's Director of Materials and Technology, Claudia Allison, spent at least 25% of her time over a period of approximately two years innovating, developing, and conceiving of the technologies for the New Products, which were later claimed in the patents and patent application attached hereto as **Exhibits D-F**. Ms. Allison was the principal author of the content for the patent application that became U.S. Patent No. 6,777,966, which is attached hereto as **Exhibit D,** and from which U.S. Patent No. 7,202,683 (**Exhibit E**) is a continuation patent. Due to Gel-Pak's significant contributions to the conception of the technologies and inventions claimed in the Patents, Ms. Allison should be named as a joint inventor on each of the Patents and Gel-Pak should be joint owner or assignee of each of the Patents.

37. After U.S. Patent No. 6,777,966 (attached hereto as **Exhibit D**) was issued on August 17, 2004, Gel-Pak approached Defendants and inquired as to why Gel-Pak had not been granted joint ownership or assignment of the patent. In response to Gel-Pak's inquiry, Defendants claimed that the rights of inventorship and ownership were not of any consequence because the patent and its inventions were worthless. In January of 2005, Defendants represented to Gel-Pak (through at least Defendants Freeze and Humphrey) that they would undertake to correct the inventorship of the patent and grant Gel-Pak joint ownership and/or assignment of the patent if Gel-Pak agrees to pay Defendants $15,000.00; this sum was allegedly chosen to represent some percentage of some financial figure relating to the monies that Defendants expended in the filing and prosecution of the patent application. Based on Defendants' representations regarding the lack of value of the patent, and because the $15,000.00 was an exorbitant sum to undertake the correction of inventorship and ownership, both which are routine filings that take no more than a few hours of attorney time to initiate and complete, Gel-Pak did not agree to pay Defendants $15,000.00 to correct the

inventorship and ownership of the patent. Because Gel-Pak is now aware that the Patents are not worthless, but rather, have substantial value and potential value, Gel-Pak seeks to correct the inventorship of the Patents to include Ms. Allison and to correct the ownership of the Patents so that Gel-Pak is at least a joint owner or assignee of the Patents.

FIRST CLAIM FOR RELIEF

Breach of Contract (Against All Defendants)

38. The allegations of paragraphs 1-37 above are hereby re-alleged and incorporated herein by reference.

39. Under the Distribution Agreement, Defendants were obligated, among other things, to actively and aggressively promote and sell throughout the world the Test Products, obtain its supply of Test Products only from Gel-Pak, pay royalties to Gel-Pak for any gross revenues over $1,000,000 received from sales of New Products, and adhere to confidentiality obligations regarding Gel-Pak's proprietary and trade secret information.

40. Gel-Pak has performed all conditions, covenants, and promises required to be performed in accordance with the terms and conditions of the Distribution Agreement, except as excused by Defendants, through the present time.

41. Defendants have materially breached the Distribution Agreement by:

a. Failing to actively solicit orders and aggressively promote the Test Products worldwide as required by Section 2.2 of the Distribution Agreement, in that Defendants are actively selling their own products instead of the Test Products;

b. Failing to engage in sales and promotional activities worldwide for the Test Products as required by Section 2.5 of the Distribution Agreement, in that Defendants are actively selling their own products instead of the Test Products;

c. Failing to devote such time and resources as may be reasonably necessary to solicit and obtain sufficient orders for the Test Products to meet the sales expectations as outlined in Exhibit B to the Distribution Agreement and to fulfill all of Defendants' other duties described in the Distribution Agreement, all as required by Section 2.6 of the Distribution Agreement;

d. Failing to provide Gel-Pak with copies of a quarterly demand forecast as required by Section 2.4 of the Distribution Agreement;

e. On information and belief, failing to pay Gel-Pak royalties owed for sales of New Products (including at least Probe Scrub and Probe Polish) over the threshold of $1,000,000 in gross revenue received for sales of such New Products, as required by Section 8.1 of the Distribution Agreement, and potentially further including the failure to pay Gel-Pak royalties under Section 8.1 based on gross revenue received for sales of the Probe Clean product Gel-Pak has discovered Defendants were selling without Gel-Pak's involvement, depending on whether that product is considered an Existing Product or a New Product governed by Section 3.3;

f. On information and belief, violating the intellectual property provision set forth in Section 7.1 of the Distribution Agreement by the unlicensed use of Gel-Pak's Proprietary Information to manufacture competing products or to assist third parties in the the manufacture of competing products; and

g. On information and belief, violating the confidentiality provision set forth in Section 15 of the Distribution Agreement by disclosing Gel-Pak's Proprietary Information to a third party or third parties for the purpose of manufacturing probe cleaning products without Gel-Pak's knowledge or consent and by failing to restrict dissemination of Gel-Pak's proprietary information to employees of Defendants with a need to know that information.

42. The actions of Defendants as alleged herein have deprived Gel-Pak of the benefit of the bargain to which it is legally entitled, in breach of the parties' Distribution Agreement contract.

43. As a legal and proximate cause of Defendants' breach of contract, Gel-Pak has sustained and will continue to sustain substantial economic damages. On information and belief, Gel-Pak alleges that its damages approximate or exceed $500,000. The precise nature and amount of such accrued and continuing damages is not presently known to Gel-Pak, and cannot be ascertained with any definitiveness at this time, but Gel-Pak's actual and continuing damages will be proven at trial.

SECOND CLAIM FOR RELIEF

Breach of the Implied Covenant of Good Faith and Fair Dealing

California Common Law and California Commercial Code Sections 1304 and 1302(b)

(Against All Defendants)

44. The allegations of paragraphs 1-43 above are hereby re-alleged and incorporated herein by reference.

45. The Distribution Agreement includes an implied covenant of good faith and fair dealing pursuant to the common law of California and California Commercial Code Sections 1304 and 1302(b). By entering into the Distribution Agreement by which Defendants agreed to, among other things, actively and aggressively promote and sell the Test Products throughout the world for the mutual benefit of the parties, obtain its supply of Test Products only from Gel-Pak, pay royalties to Gel-Pak for any gross revenues over $1,000,000 received from sales of New Products, and honor their confidentiality obligations regarding Gel-Pak's proprietary and trade secret information, there existed, and exists, an implied covenant of good faith and fair dealing under which Defendants were and are obligated to act reasonably and fairly toward Gel-Pak in connection with their contractual agreement and business relationship relating thereto, and to not take any action intended to deprive Gel-Pak of the benefits to which it was and is entitled under the Distribution Agreement.

46. On information and belief, and in addition to the allegations of specific contractual violations detailed in Gel-Pak's First Claim for Breach of Contract above, Defendants have breached the implied covenant of good faith and fair dealing by manufacturing (or having a third party manufacture) the Test Products and selling those products instead of ordering and selling Test Products provided by Gel-Pak, by misappropriating and using Gel-Pak's proprietary information and trade secrets in order to engage in such sales and thereby circumvent its obligations to Gel-Pak under the Distribution Agreement, and by dissolving Defendant ITS California in order to disavow and avoid compliance with its contractual obligations to Gel-Pak.

47. The actions of Defendants alleged herein have indeed deprived Gel-Pak of the benefit of the bargain to which it is legally entitled, in breach of the implied covenant of good faith

and fair dealing existing in the parties' Distribution Agreement contract.

48. As a legal and proximate cause of Defendants' breach of the implied covenant of good faith and fair dealing, Gel-Pak has sustained and will continue to sustain substantial economic damages. On information and belief, Gel-Pak alleges that its damages approximate or exceed $500,000. The precise nature and amount of such accrued and continuing damages is not presently known to Gel-Pak, and cannot be ascertained with any definitiveness at this time, but Gel-Pak's actual and continuing damages will be proven at trial.

THIRD CLAIM FOR RELIEF

Willful Misappropriation of Trade Secrets

California Civil Code Section 3426 *et seq.* (Against All Defendants)

49. The allegations of paragraphs 1-48 above are hereby re-alleged and incorporated herein by reference.

50. Gel-Pak's confidential and proprietary information described above, including its proprietary Gel compound formulas and the manufacturing processes through which it creates the Gels and applies them to various substrates, constitutes trade secrets within the meaning of California Civil Code Section 3426 *et seq.*, and particularly, Section 3426.1(d). The trade secrets derive independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from their disclosure or use, and are the subject of efforts by Gel-Pak that are reasonable under the circumstances to maintain their secrecy, all as described above.

51. Defendants obtained access to Gel-Pak's trade secrets pursuant to non-disclosure agreements and other contractual obligations of confidentiality, and based on express representations that they would maintain the confidentiality of Gel-Pak's trade secrets. Gel-Pak is informed and believes that Defendants made these representations and undertook these obligations of confidentiality with no intent to honor them, and instead with the intent to acquire, use, and disclose Gel-Pak's trade secrets for their own benefit. Gel-Pak had no knowledge of and no reason to suspect Defendants' secret intent to misappropriate its trade secrets, and justifiably relied on

Defendants' representations and contractual obligations of confidentiality. As a result, Gel-Pak provided Defendants with access to its trade secrets beginning in 1999, and continuing through at least 2001.

52. On information and belief, Defendants have misappropriated Gel-Pak's trade secrets by wrongfully acquiring them, using them for their own benefit without Gel-Pak's knowledge or consent, and disclosing Gel-Pak's trade secrets to third parties without Gel-Pak's knowledge or consent, all for the unlawful purpose of profiting from the manufacture and sale of probe cleaning products without having to account to Gel-Pak therefor.

53. Defendants' misappropriation was accomplished through the use of improper means, including but not limited to, the breach of their contractual duties to Gel-Pak to maintain the confidentiality of Gel-Pak's trade secrets and only use or disclose them in approved ways for the mutual benefit of the parties. On information and belief, the wrongful and unlawful disclosures by Defendants include, but are not limited to, disclosures to other third parties, for purposes including manufacturing probe cleaning products that make use of Gel-Pak's proprietary and trade secret information. On information and belief, Defendants further misappropriated Gel-Pak's trade secrets by the unlicensed use of Gel-Pak's trade secrets to manufacture competing products or to assist third parties in the the manufacture of competing products in violation of their obligations under the Distribution Agreement (**Exhibit A**) and the non-disclosure agreement (**Exhibit B**). On information and belief, Defendants' disclosure and improper use of Gel-Pak's trade secrets commenced prior to October, 2004.

54. By virtue of the acts and omissions of Defendants as alleged above, Defendants are guilty of actual and threatened misappropriation of Gel-Pak's trade secrets, including willful and malicious misappropriation within the meaning of California Civil Code Section 3426 *et seq.*, thereby entitling Gel-Pak to injunctive and monetary relief as set forth in California Civil Code Sections 3426.2 and 3426.3 respectively, in an amount to be proven at trial. On information and belief, Gel-Pak alleges that its damages approximate or exceed $500,000.

55. By virtue of the acts and omissions of Defendants as alleged above, Defendants are

guilty of actual and threatened misappropriation of Gel-Pak's trade secrets, including willful and malicious misappropriation within the meaning of California Civil Code Section 3426 *et seq.*, thereby further entitling Gel-Pak to exemplary damages as set forth in California Civil Code section 3426.3 and reasonable attorneys' fees as set forth in California Civil Code section 3426.4, in an amount to be proven at trial and/or determined by the Court.

56. On information and belief, Defendants are continuing to engage in the wrongful acts of misappropriation alleged in this Complaint, causing serious and irreparable harm and damage to Gel-Pak. On information and belief, Defendants have used and disclosed using improper means, and will continue to use and disclose using improper means, Gel-Pak's trade secrets in order to unfairly compete with and otherwise harm Gel-Pak, unless restrained by this Court.

57. Gel-Pak has no adequate remedy at law to compel Defendants to cease their wrongful misappropriation. Unless the Court grants an injunction, Gel-Pak will be compelled to prosecute a multiplicity of actions, one each time Defendants wrongfully make use of and/or disclose Gel-Pak's trade secrets. The harm to Gel-Pak is irreparable because it is extremely difficult to ascertain the amount of compensation that will afford Gel-Pak adequate relief if Defendants are not enjoined at this time.

FOURTH CLAIM FOR RELIEF

Statutory Unfair Competition

California Business & Professions Code Section 17200 (Against All Defendants)

58. The allegations of paragraphs 1-57 above are hereby re-alleged and incorporated herein by reference.

59. On information and belief, Defendants' conduct as alleged in this Complaint (including, but not limited to, their acts of willful misappropriation of trade secrets for purposes of engaging in direct competition with Gel-Pak and contravening the Distribution Agreement) constitutes unlawful, unfair, and/or fraudulent business acts or practices in violation of California Business & Professions Code Section 17200 *et seq.*, resulting in Defendants' unjust enrichment, for which Gel-Pak is entitled to relief under California Business & Professions

Code Section 17200 *et seq.*

60. On information and belief, Gel-Pak alleges that Defendants are continuing to engage in one or more acts of unfair competition to Gel-Pak's substantial economic detriment, involving Defendants' acts of fraud and their willful misappropriation of trade secrets for purposes of engaging in direct competition with Gel-Pak and contravening the Distribution Agreement between Gel-Pak and Defendants. Gel-Pak has no adequate remedy at law to compel Defendants to cease their wrongful acts, and therefore seeks injunctive relief. Unless the Court grants an injunction, Gel-Pak will be compelled to prosecute a multiplicity of actions to remedy this continuing unfair, unlawful, and/or fraudulent conduct. Gel-Pak's damages are irreparable because it is extremely difficult to ascertain the amount of compensation that will afford Gel-Pak adequate relief if Defendants are not enjoined at this time. On information and belief, Gel-Pak alleges that its damages approximate or exceed $500,000.

FIFTH CLAIM FOR RELIEF

Correction of Inventorship and Exceptional Case

Under the Patent Laws of the United States at 35 U.S.C. §§ 256 and 285

(Against All Defendants)

61. The allegations of paragraphs 1-60 above are hereby re-alleged and incorporated herein by reference.

62. As described and alleged above, Gel-Pak, through at least Claudia Allison (Gel-Pak's Director of Materials and Technology), invested a significant degree of time, energy, and expense innovating, developing, and conceiving of the technologies and inventions claimed in the Patents. As such, the Patents should name Claudia Allison as a joint inventor on the Patents. Further, Gel-Pak has a right to insist upon the correction of the inventorship of the Patents to include Ms. Allison pursuant to the patent laws of the United States, including at least 35 U.S.C. §§ 116 and 256.

63. The omission of Claudia Allison as an inventor on the Patents was not made with any deceptive intent on the part of Ms. Allison or Gel-Pak.

64. As described and alleged above, upon Gel-Pak's request for Defendants to correct the

inventorship on the Patents to include Ms. Allison, Defendants intentionally misrepresented the value of the Patents and refused to correct the inventorship without receiving an unreasonably high sum of money to undertake the correction. Based upon Defendants' failure to correct the inventorship as was legally required of them when the omission was brought to Defendants' attention by Gel-Pak; the demand for an unreasonably high sum of money from Gel-Pak in order to undertake the correction of inventorship; and Defendants' misrepresentations to Gel-Pak regarding the value of the Patents, Gel-Pak respectfully requests that this Court declare this case as exceptional under 35 U.S.C. § 285.

65. Pursuant to 35 U.S.C. § 256, Gel-Pak respectfully requests that this Court order Defendants to correct the inventorship of the Patents to include Claudia Allison as a joint inventor on the Patents and to declare this case as an exceptional case under 35 U.S.C. § 285 and order Defendants to pay Gel-Pak its costs and reasonable attorneys' fees in an amount to be proven at trial and/or determined by the Court.

SIXTH CLAIM FOR RELIEF

Declaratory Relief

Under the Distribution Agreement and California Law (Against All Defendants)

66. The allegations of paragraphs 1-65 above are hereby re-alleged and incorporated herein by reference.

67. As described and alleged above, Gel-Pak, through at least Claudia Allison (Gel-Pak's Director of Materials and Technology) invested a significant degree of time, energy, and expense to innovate, develop, and conceive of the technologies and inventions developed by the parties, which include the technologies of the New Products. Gel-Pak therefore has a right to insist upon at least joint ownership and/or joint assignment (if not sole ownership and/or sole assignment) of the Patents, New Products, and any other intellectual property associated therewith, all pursuant to Section 7.2 of the Distribution Agreement (**Exhibit A**), which provides that if "any intellectual property is developed under this Agreement in the course of developing the New Products, said

developed intellectual property ***shall be jointly owned***[1] and governed by the various laws governing ownership of intellectual property." A justiciable case or controversy that is ripe for review exists as to whether and under what conditions Gel-Pak should be granted at least joint ownership and/or joint assignment of the New Products and the intellectual property and technology associated therewith.

68. As such, Gel-Pak respectfully requests that, pursuant to the federal Declaratory Judgment Act, 28 U.S.C. § 2201, and under Section 7.2 of the Distribution Agreement between Gel-Pak and ITS (**Exhibit A**) that the Distribution Agreement contract invokes, this Court exercise its equitable powers to issue declaratory relief in the form of a declaratory judgment ordering that Gel-Pak be granted at least joint ownership and/or joint assignment of the Patents, New Products, and any other intelectual property and technology associated with the development of the New Products.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff Gel-Pak prays for the following relief:

A. That the Court order Defendants to provide Gel-Pak and the Court with an accounting of all its sales of, and gross revenues for, all probe cleaning products from October 1, 1999 to the present, based on Gel-Pak's First through Fifth Claims;

B. For compensatory damages of at least $500,000 according to proof, based on Gel-Pak's First through Fifth Claims;

C. For exemplary damages based on Gel-Pak's Claim for Willful Misappropriation of Trade Secrets (through California Civil Code Section 3426.3);

D. For a preliminary injunction and permanent injunction preventing Defendants from using and/or disclosing Gel-Pak's confidential and proprietary information and trade secrets and preventing Defendants from engaging in further acts of unlawful competition against Plaintiffs, based on Gel-Pak's Claim for Willful Trade Secret Misappropriation (through California Civil Code

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[1] Bold-italic emphasis added.

Section 3426.2) and Claim for Statutory Unfair Competition (through California Business & Professions Code Section 17535);

E. Order correction of the Patents pursuant to 35 U.S.C. § 256 to list Claudia Allison as a joint inventor on the Patents;

F. Declare this case exceptional pursuant to 35 U.S.C. § 285 and award Gel-Pak its costs and reasonable attorneys' fees;

G. For a declaratory judgment ordering that Gel-Pak shall be granted at least joint ownership and/or joint assignment of the Patents and the New Products under the Distribution Agreement;

H. For reasonable attorneys' fees, based on Gel-Pak's Third Claim for Willful Misappropriation of Trade Secrets (through California Civil Code Section 3426.4) and any other applicable provisions of California or federal law;

I. For interest on all damages;

J. For costs of suit; and

K. For such other and further relief as the Court deems just and proper.

Dated: March 21, 2011

NIXON PEABODY LLP

By _____
GREGORY P. O'HARA
LISA A. COLE
Attorneys for Plaintiff DELPHON INDUSTRIES, LLC dba GEL-PAK

DEMAND FOR JURY TRIAL

In accordance with Federal Rule of Civil Procedure 38(b), Plaintiff Delphon Industries, LLC dba Gel-Pak hereby demands a jury trial on all issues triable of right by a jury.

Dated: March 21, 2011

NIXON PEABODY LLP

By _____
GREGORY P. O'HARA
LISA A. COLE
Attorneys for Plaintiff DELPHON INDUSTRIES, LLC dba GEL-PAK

EXHIBIT A

DISTRIBUTION AGREEMENT

THIS AGREEMENT is made and entered into on this 1st day of October, 1999, by and between Gel-Pak LLC, a Delaware Limited Liability Company, with its principal place of business at 756 North Pastoria Avenue, Sunnyvale, California, 94086 (hereafter "Supplier") and International Test Solutions, Inc., a California corporation, with its principal place of business at 2479 Chardonnay Way, Livermore, California, 94550 (hereafter "Distributor").

WHEREAS, Supplier develops, manufactures, and sells products for use in the semiconductor and disk drive industries (referred to herein as "Existing Products") and wishes to expand its markets and product offerings;

WHEREAS, Supplier has valuable intellectual property including patents, tradescrets, and know-how which it has developed in the course of developing and selling Existing Products in the semiconductor and disk drive industries;

WHEREAS, Distributor has identified a line of "new" products which it desires to develop and sell to the semiconductor industry for use in wafer test probe cleaning, polishing, and scrubbing which employ a combination of an abrasive and a polymer or a polymer and a chemical (referred to herein as "New Products");

WHEREAS, Distributor has identified a market segment for products to be used by the semiconductor industry to clean devices used in testing wafers, die or package parts and/or cleaning substrates and other associated items used in testing semiconductor devices (referred to herein as the "Test Market").

WHEREAS, Distributor and Supplier expect to receive mutual benefit from the Distributor actively marketing the Supplier's Existing Products and the New Products (collectively referred to herein as "Test Products") to the Test Market on an exclusive basis.

WHEREAS, Distributor wishes for Supplier to develop the New Products to be exclusively distributed and sold by the Distributor; and

WHEREAS, Distributor recognizes that Supplier has valuable intellectual property

including patents, trade secrets, and know-how which Supplier will be using to develop the New Products.

NOW, THEREFORE, Supplier and Distributor agree as follows:

1. Product Development:

The Supplier and Distributor agree to work together to specify and develop Test Products for use in the Test Market . Identified in Exhibit A is a non-exhaustive list of examples of New Products. Supplier will use its best efforts to meet Distributors product specifications in a timely manner. Distributor will provide Supplier with written specifications, drawings, data sheets, and other details of the New Products.

2. Sales Distributor Duties

The Distributor, at the sole expense of the Distributor, shall:

2.1 Conduct all its businesses in its own name.

2.2 Actively solicit orders and aggressively promote the Test Products worldwide.

2.3 Maintain an office(s) and staff at its own expense to accomplish the sale of the Test Products.

2.4 Provide to Supplier copies of a quarterly demand forecast.

2.5 Engage in sales promotional activities worldwide and develop and distribute printed matter, such as catalogs, data sheets, specifications, sales aids, process information, technical reprints as available, price lists to subsidiary companies, affiliates and to current and potential customers. The Test Products will at all times be designated by their correct International Test Solutions, Inc. names and identified as products of International Test Solutions, Inc. Copies of all promotional and marketing materials will be supplied to Supplier for reference.

2.6 Devote such time and resources as may be reasonably necessary to solicit and obtain sufficient orders for the Test Products to meet the sales expectations as outlined in Exhibit B and to fulfill all Distributors other duties described herein.

3. Duties of the Supplier:

The Supplier shall, at no expense to the Distributor:

3.1 Make reasonable efforts to develop the New Products in a timely manner using care and discretion to protect Distributor's product ideas.

3.2 Manufacture the Test Products to consistently meet the technical and quality specifications of the Distributor. Supplier shall use reasonable resources to meet the Distributor's quantity forecasts provided on a periodic basis.

3.3 Within 60 days of Distributor having provided detailed specifications for a New Product Supplier shall determine whether to make or to decline to make the New Product that the Distributor requested. Should Supplier decline to make a requested New Product, Distributor shall be free to develop the declined New Product without making use of Supplier's intellectual property. Said declined New Product shall be construed to be outside of the terms of this Agreement.

3.4 Supplier agrees to sell to Distributor all Test Products under this Agreement at prices consistent with other products sold to other large volume customers, which price shall include all manufacturing costs, overhead and reasonable profit.

3.5 Supplier will forward to Distributor all sales leads or inquiries, which Supplier may receive for the Test Products. Supplier will assist Distributor as needed in the development of product collateral.

3.6 Supplier will furnish samples and supplies of its standard technical literature for Suppliers existing products in reasonable quantities at Supplier's cost or a such prices as may hereafter be agreed upon. Promotional and technical literature is subject to revision at any time without prior notice.

3.7 Supplier will make no promotion, or solicit orders, in the Test Market, and will not compete with the Distributor in the Test Market, although both parties recognize the incidental sales may occur without the Supplier's knowledge.

3.8 Supplier will sell existing products to the Distributor for resale into the Test Market at prices consistent with products sold to other large volume customers using a standard purchase order.

4. <u>Appointment of Distributor:</u>

4.1 Subject to all of the terms and conditions of the Agreement, Supplier hereby appoints; Distributor, and Distributor hereby accepts such appointment, as the sole and exclusive Distributor of the Test Products to

the Test Market worldwide. The Distributor and the Supplier also hereby agree that the Distributor will sell existing products to the Test Market on a non-exclusive basis.

4.2 Supplier shall sell the Test Products to Distributor. F.O.B. ex factory or ex Supplier's distribution center, at prices consistent with standard margins for large volume customers.

4.3 Terms and conditions of Supplier's payment terms are FOB Sunnyvale, California USA and Net 30 days from date of invoice with a 15 day extension for distributors.

5. Status of Distributor:

The Distributor is an independent contractor, not an employee of the Supplier, and does not have the authority to enter into any agreement in the name of the Supplier.

6. Satisfaction of Distributor Orders:

Supplier shall make reasonable best efforts to fill orders from Distributor consistent with the demand forecast. Order quantities received from the Distributor beyond the anticipated production quantities forecast will be quoted by the Supplier. All orders are subject to acceptance or rejection by an authorized officer of the Supplier at its office.

7. Intellectual Property, Trademarks and Markings:

7.1 Supplier agrees to provide Distributor with a non-exclusive license to any intellectual property Supplier owns necessary to enable Distributor to distribute and sell the Test Products into the Test Market. Said license to Supplier intellectual property shall terminate upon the termination of this Agreement.

7.2 In the event that any intellectual property is developed under this Agreement in the course of developing the New Products, said developed intellectual property shall be jointly owned and governed by the various laws governing ownership of intellectual property. Should the developed intellectual property be owned solely by Supplier, Supplier agrees to grant Distributor a non-exclusive license in the field as defined by the New Products identified in Exhibit A to enable Distributor to distribute and sell the New Products. Should the developed intellectual property be owned solely by Distributor, Distributor agrees to grant Supplier a non-exclusive license in all fields of use. Should the developed intellectual property be jointly owned by Distributor and Supplier, Distributor and Supplier agree to grant each other a non-exclusive license in all fields of use. Said license

to intellectual property developed during the course of developing the New Products shall be perpetual beyond the termination of this Agreement.

7.3 Distributor and Supplier shall use their best efforts to protect the New Products they develop and market through application for trademarks and copyrights as may be prudent and will work together for their mutual benefit to develop brand name identification for the New Products (described in Exhibit A attached hereto). Distributor and Supplier may use all trademarks, copyrights, and brand names in their promotional material for the purpose of furthering the purpose of this agreement.

8. Royalties:

8.1 In consideration for the valuable intellectual property which Supplier will unavoidable contribute into the development of the New Products, Distributor hereby agrees to pay Supplier the following cumulative royalties, to be payable as such royalties are accrued:

no royalty on the first $1,000,000 of gross sales of the New Products regardless of whether the New Products are supplied by Supplier; and

a 15% royalty on the gross sales of the New Products between $1,000,000 and $4,666,667 regardless of whether the New Products are supplied by Supplier; and

a 5% royalty on the gross sales of the New Products in excess of $4,666,667 regardless of whether the New Products are supplied by Supplier.

8.2 Royalties accrued under this Agreement are payable 60 days after invoice.

9. Termination:

This Agreement shall become effective as of October 1, 1999 and shall remain in effect until terminated with a one hundred and eighty (180) day notice by either party.

In the event of termination the following shall apply:

9.1 If this Agreement is terminated by either party, the provisions of Sections 7, 10-12 shall continue to remain in effective.

9.2 If this agreement is terminated by the Distributor royalties due under Section 8 of this Agreement shall continue to accrue to the Supplier until 10 years after the effective date of this Agreement.

9.3 Upon termination, Distributor shall cease being a Distributor for the Supplier. Existing and potential customers for the Test Products within the defined field with whom the Distributor has marketing efforts in progress shall remain the sole property of the Distributor and the Supplier shall not market to the Distributor's customers for a period of three (3) years following termination of the Agreement.

10. Payment:

Payment for sales of Test Products to Distributor shall be paid by Distributor within thirty (30) days after the invoice requesting said payment.

11. Taxes:

Distributor shall bear all applicable federal, state, municipal, and other government taxes (such as sales, use, value added, or any similar taxes); all customs duties, imposts, and similar charges; and all personal property taxes assessable on the Test Products after delivery to the carrier at Supplier's plant.

12. Warranty:

The Supplier warrants to the Distributor for a period of thirty (30) days from the date of original shipment to the Distributor or Customer that the Test Products delivered by Supplier to Distributor or Customer pursuant to this Agreement shall be free from defects in materials and workmanship. Suppliers obligation under the warranty is limited to replacing or repairing, at its factory, any of the Test Products (except expendable parts thereof) that within the warranty period are returned to Supplier and that are found by Supplier to be defective. Should the returned items be found to be defective Supplier will pay transportation costs in both directions. The Supplier makes no further warranty as to fitness of the Test Products for a particular purpose or any warranty, express of implied which extends beyond descriptions of similar products in the Supplier's published materials. Distributor assumes all risk and liability for loss or damage resulting from the use of the Test Products by Customers whether used singly or in combination with other materials.

13. Choice of Law:

This Agreement shall be interpreted and construed in accordance with the laws of the State of California, without regard to conflicts of law principals.

14. Assignment:

14.1 The obligations of each party under this Agreement shall run in favor of their successors and assigns or other legal representatives.

14.2 The rights and licenses granted in this Agreement are personal and may not be assigned or otherwise transferred without the written consent of the other party, and any attempted transfer thereof without such consent shall be void provided, however, that either party may assign this Agreement pursuant to a sale of the party's entire business relating to the subject matter of this Agreement upon an undertaking by that assignee, in writing, to be bound by all of the obligations of this Agreement.

15. Confidential Information:

Each party agrees that any data, information drawings and/or materials, (Proprietary Information) whether or not protected by any form of intellectual property, including patent, trademark, copyright, tradesecret or otherwise, including but not limited to, technical specifications shall be treated as confidential and shall not be disclosed to any third party without prior written consent of a duly authorized officer of the owner of the Proprietary Information for a period of five (5) years after disclosure of such Proprietary Information. The Proprietary Information shall not be reproduced, provided, or otherwise make available any person other than those employees who have a need to know for the purpose of performing this Agreement. Each party agrees that any such employees to whom Proprietary Information is disclosed shall first execute an agreement not to disclose any Proprietary Information to any third party without the prior written permission.

16. Titles and Subtitles:

The titles and subtitles used in this Agreement are for convenience only and are not a part of this Agreement and do not in any way limit or amplify the terms and provisions of this Agreement.

17. Entire Agreement:

This Agreement hereto contain the entire agreement between the parties hereto and supersede any prior oral or written agreements pertaining to the same subject matter Neither party hereto has relied on any oral or written representation by the other not contained herein in entering into this Agreement.

18 Severability.

In the event that any provision of this Agreement becomes or is declared by a court of competent jurisdiction to be illegal, unenforceable or void, the remainder of this Agreement shall continue in full force and effect without said provision.

19 Force Majeure:

Nonperformance of either party shall be excused to the extent that performance is rendered impossible by strike, fire, earthquake, flood, governmental acts or orders or restrictions, failure of suppliers, or any other reason where failure to perform is beyond the reasonable control and not caused by the negligence of the non-performing party.

20. Notices:

Any notice required or permitted to be given to the parties hereto shall be deemed to have been properly given if delivered in person or when received if mailed by first-class mail to the other party at the appropriate address as set forth below or to such other addresses as may be designated in writing by the parties from time to time during the Term of this Agreement.

IN WITNESS THEREOF, the parties have executed this Agreement to be effective as of the date specified above.

International Test Solutions, Inc.	Gel-Pak, LLC
By: Billie Joyce Freeze	By: Jeanne Beacham
Billie Joyce Freeze	Jeanne Beacham
Title: CEO	Title: President
Date: 10/22/99	Date: 10/22/99

EXHIBIT A

New Product Definitions:

1. Probe Polish - polymer with abrasive grit
2. Probe Scrub - non-abrasive polymer on abrasive polyester substrate
3. Probe Scrub - non-abrasive polymer on ceramic substrate
4. Chem Clean - non-abrasive polymer in combination with chemicals

Existing Product Definitions:

1. Probe Clean - non-abrasive polymer on polyester or silicon wafer (WF, DGL)

Exhibit B

Sales expectations by product for the year ended December 31, 2000:

	Product	Quantity (units)
New Product Definitions:		
1.	Probe Polish - polymer with abrasive grit	10,000
2.	Probe Scrub - non-abrasive polymer on abrasive polyester substrate	5,000
3.	Probe Scrub - non-abrasive polymer on ceramic substrate	1,500
4.	Chem Clean - non-abrasive polymer in combination with chemicals	2,500
Existing Product Definitions:		
1.	Probe Clean - non-abrasive polymer on polyester or silicon wafer (WF, DGL)	15,000

These minimum production quantities are superseded by the first demand forecast specified in (paragraph 2.4) and agreed to by both the Supplier and Distributor.

EXHIBIT B

MUTUAL NON-DISCLOSURE AGREEMENT

This Mutual Nondisclosure Agreement ("Agreement") is entered into effective as of signature date below (the "Effective Date"), between ITS * (hereinafter the "Undersigned party"), a CA company, located at 2479 Charpentier Way, Livermore CA and GEL-PAK, a limited liability corporation located at 756 North Pastoria Avenue, Sunnyvale, CA 94086, for the purpose of protecting and preserving the confidential and/or proprietary nature of information to be disclosed or made available by either party to each other under this Agreement.

Both parties agree as follows:

Proprietary Information disclosed under this Agreement shall be used solely for the purpose of DEVELOPING ADDITIONAL PRODUCTS FOR CLEANING PROBE CARDS.

Proprietary Information shall include any information which is disclosed in tangible form clearly labeled as confidential, or the equivalent, or if disclosed initially in any other form, identified, in writing and confirmed as confidential within thirty days after initial disclosure.

In consideration of receiving the Information, both parties agree to use any proprietary information provided pursuant to this Agreement for the above purpose only, unless otherwise hereafter agreed to in writing by each party, and to maintain the proprietary information with the same degree of care which it employs with respect to its own proprietary information which it desires to keep confidential, and will treat the Information with such care.

This Agreement shall impose no obligation with respect to any portion of the proprietary information as evidenced by written records which:

1) is now, or which hereafter, through no act or failure to act, becomes generally known or available;
2) is known to the other party at the time such information is received as evidenced by written records;
3) is hereafter furnished to the other party by a third party as a matter of right and without restriction on disclosure;
4) is furnished to others by the disclosing party without restriction on disclosure; or
5) is disclosed after five (5) years from receipt of the proprietary information.

Both parties agree to promptly return all copies of any proprietary information provided pursuant to this Agreement upon the request of the other party within 30 days of the request.

No license under any patent, patent application, trademark, copyright or other right to use the proprietary information is granted directly, indirectly or by inference by this Agreement or the action of providing proprietary information pursuant to this Agreement.

Neither party makes any warranty either as to accuracy of the proprietary information or that any new products will be produced as disclosed; nor does either party warrant the availability of any product on any specific date.

Both parties agree that this Agreement and disputes arising thereunder are governed by the laws and courts of the State of California, United States of America.

UNDERSTOOD AND AGREED:

By: Alan E. Humphrey (duly authorized)	By: Jeanne Beacham (duly authorized)
Name: Alan E. Humphrey	Name: Jeanne Beacham
Title: President	Title: President
Date: 8/9/99	Date: 8/9/99

* Interchangeable with IST Solutions, Inc.

EXHIBIT C

MP-CITR DATE: 8-7,8 **2000**
(Date Disclosure(s) will commence)

CNDA NUMBERS: (1) 7169747
(2) 7504446
(3) _____
(Fill in Numbers from Executed CNDAs for each Participant)

MULTI-PARTY CONFIDENTIAL INFORMATION TRANSMITTAL RECORD ("MP-CITR")

Participants' Names:(1) CEC-PAK, LLC
(Use Same Names as on CNDA)
(2) International Test Solutions Inc
(3) _____

Location of Disclosure: 756 N. PASTORIA, SUNNYVALE, CA 94086
Street Address City State Zip Code

The parties agree that the Confidential Information described below shall be kept confidential. However, the parties may disclose the Confidential Information among themselves. This MP-CITR incorporates all the terms and conditions of the Corporate Non-Disclosure Agreement ("CNDA") executed by each party.

1. Describe Confidential Information disclosed by each party. (Be specific. Include subject or product, any document title, drawing/document number, date, rev., etc.) Identify visuals, foils, and verbal disclosures. (Use additional sheets if necessary).
   Intel Confidential Information: _____

   Participants' Confidential Information: CEC-PAK'S QUALITY POLICIES AND PROCEDURES, VARIOUS MANUFACTURING DOCUMENTATION, MFG. PROCEDURES & TECHNIQUES ALL RELATED TO INTEL'S SCRA.
2. This MP-CITR covers the above described Confidential Information to be conveyed commencing on the date stated above, provided it is marked as required under the CNDA. The parties agree that the Confidential Information described in this MP-CITR disclosed to any one party may be disclosed to any other party who is a signatory to this MP-CITR.
3. Unless a shorter period is indicated below, the disclosing party will not assert any claims of breach or misappropriation of trade secrets against the receiving party arising from the receiving party's disclosure of the disclosing party's Confidential Information under this MP-CITR more than five (5) years from the date when such information was disclosed. However, unless at least one of the exceptions set forth in Section 4 of the CNDA has occurred, the receiving party will continue to treat such Confidential Information as the confidential information of the disclosing party and only disclose any such Confidential Information to third parties under the terms of a non-disclosure agreement.

   If initialed and filled in below, the period after which the disclosing party agrees not to assert claims against the receiving party with respect to the Confidential Information disclosed under this MP-CITR will be _____ months (not less than twenty-four (24) months nor more than sixty (60) months). (____/____)
4. Confidential Information may be controlled by U.S. Export Regulations, and export, re-export or foreign disclosure (including to subsidiary employees) may require U.S. Government approval. The receiving party shall not use, export, transfer, make available or otherwise disclose any Confidential Information in violation of U.S. Export Regulations, including any use or development in nuclear, missile, chemical and/or biological weapons activities.
5. Any party may at any time request in writing the immediate return of all or part of its Confidential Information disclosed hereunder, and all copies thereof, and each receiving party shall promptly comply with such request.
6. All other terms and conditions of each executed CNDA shall remain in full force and effect. Nothing contained herein shall be construed as amending or modifying the terms of the CNDAs referenced above.
7. All parties understand and acknowledge that no license under any patent, copyright, trade secret or other intellectual property right is granted to or conferred upon any party in this Agreement or by the disclosure of any Confidential Information by one party to any other party as contemplated hereunder, either expressly, by implication, inducement, estoppel or otherwise, and that any license under such intellectual property rights must be express and in writing.

INTEL CORPORATION
2200 Mission College Blvd., Santa Clara, CA 95052-8119

By [signature]
Title Commodity Manager
Date 8-7-00

PARTICIPANT (1):
(Company Name, Division/Sub if applicable, Signature, Title)

Company Name CEC-PAK LLC
By [signature]
Title VP/CFO
Date 8-7-2000

PARTICIPANT (2):
(Company Name, Division/Sub if applicable, Signature, Title)

Company Name _____
By _____
Title _____
Date _____

PARTICIPANT (3):
(Company Name, Division/Sub if applicable, Signature, Title)

Company Name International Test Solutions
By Joyce Adams [signature]
Title Director Marketing
Date _____

USE EXTRA PAGES IF NECESSARY

PLEASE SEND THIS COPY OF THE MP-CITR TO: INTEL CORPORATION, ATTN Post Contract Management, FM6-03
1900 Prairie City Road, Folsom, CA 95630-9598 230-0000-37 (06/98)

AGREEMENT DATE: Wednesday, May 10, 2000 CNDA# 7169747

CORPORATE NON-DISCLOSURE AGREEMENT

This Corporate Non-Disclosure Agreement ("Agreement") is entered into and made effective as of the date set forth above, by and between Intel Corporation and its majority owned worldwide subsidiaries ("Intel"), and the Participant, as identified below, and its majority owned worldwide subsidiaries (the "Participant"). Unless the Participant indicates on the Participant's line below that this Agreement will apply only to a specific division or location, this Agreement will apply to the Participant's entire company worldwide.

THE PARTIES AGREE AS FOLLOWS:

1. **Confidential Information Transmittal Form.** The confidential, proprietary and trade secret information of the disclosing party ("Confidential Information") to be disclosed hereunder is that information which (i) is described in the Confidential Information Transmittal Record ("CITR") executed from time to time hereafter and (ii) is marked with a "confidential", "proprietary", or similar legend. CITRs are subject to the terms of this Agreement. CITRs will be executed, in writing or in electronic form, by the parties prior to the disclosure of Confidential Information. All Confidential Information received from the disclosing party will be in tangible form. To be considered Confidential Information, non-tangible visual and/or verbal disclosures must be identified as confidential prior to disclosure and reduced to writing, marked as provided above and delivered to the receiving party within thirty (30) days of the original date of disclosure. A mutually signed CITR form will suffice as a writing for such non-tangible disclosures between the parties. The CITR will indicate the disclosing party, a description of the Confidential Information disclosed, the names of the representatives of the parties and the date when the disclosure covered by the CITR commenced.

2. **Obligations of Receiving Party.** The receiving party will maintain the confidentiality of the Confidential Information of the disclosing party with at least the same degree of care that it uses to protect its own confidential and proprietary information, but no less than a reasonable degree of care under the circumstances. The receiving party will not disclose any of the disclosing party's Confidential Information to any employees or to any third parties except to the receiving party's employees, parent company and majority-owned subsidiaries who have a need to know and who agree to abide by nondisclosure terms at least as comprehensive as those set forth herein; provided that the receiving party will be liable for breach by any such entity. For the purposes of this Agreement, the term "employees" shall include independent contractors of each party. The receiving party will not make any copies of the Confidential Information received from the disclosing party except as necessary for its employees, parent company and majority-owned subsidiaries with a need to know. Any copies which are made will be identified as belonging to the disclosing party and marked "confidential", "proprietary" or with a similar legend.

3. **Period of Non-Assertion.** Unless a shorter period is indicated in the applicable CITR, the disclosing party will not assert any claims of breach of this Agreement or misappropriation of trade secrets against the receiving party arising from the receiving party's disclosure of the disclosing party's Confidential Information made more than five (5) years from the date of the CITR under which such information was disclosed. However, unless at least one of the exceptions set forth in Section 4 below has occurred, the receiving party will continue to treat such Confidential Information as the confidential information of the disclosing party and only disclose any such Confidential Information to third parties under the terms of a non-disclosure agreement.

4. **Termination of Obligation of Confidentiality.** The receiving party will not be liable for the disclosure of any Confidential Information which is:

   (a) rightfully in the public domain other than by a breach of a duty to the disclosing party;
   (b) rightfully received from a third party without any obligation of confidentiality;
   (c) rightfully known to the receiving party without any limitation on use or disclosure prior to its receipt from the disclosing party;
   (d) independently developed by employees of the receiving party; or
   (e) generally made available to third parties by the disclosing party without restriction on disclosure.

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7. **Residuals.** Either party may use Residuals for any purpose, including, for example, use in the development, manufacture, promotion, sale and maintenance of its products and services; provided that this right to use Residuals does not result in or amount to a license under any patents, copyrights, trademarks, or maskworks of the disclosing party. The term "Residuals" means any information retained in the unaided memories of the receiving party's employees who have had access to the disclosing party's Confidential Information pursuant to the terms of this Agreement. An employee's memory is unaided if the employee has not intentionally memorized the information for the purpose of retaining and subsequently using or disclosing it to a third party. Subject to the terms and conditions of this Agreement, the receiving party's employees shall not be prevented from using Residual information as part of the employee's skill, knowledge, talent, and/or expertise on future projects.

8. **General.**

   (a) This Agreement is neither intended to nor will it be construed as creating a joint venture, partnership or other form of business association between the parties, nor an obligation to buy or sell products using or incorporating the Confidential Information.
   (b) Both parties understand and acknowledge that no license under any patents, copyrights, trademarks, or maskworks is granted to or conferred upon either party in this Agreement or by the disclosure of any Confidential Information by one party to the other party as contemplated hereunder, either expressly, by implication, inducement, estoppel or otherwise, and that any license under such intellectual property rights must be express and in writing.
   (c) The failure of either party to enforce any right resulting from breach of any provision of this Agreement by the other party will not be deemed a waiver of any right relating to a subsequent breach of such provision or of any other right hereunder.
   (d) This Agreement will be governed by the laws of the State of Delaware without reference to conflict of laws principles, if any.
   (e) This Agreement, any accompanying CITR and CITRs executed from time to time hereafter which incorporate the terms of this Agreement, constitutes the entire agreement between the parties with respect to the disclosure(s) of Confidential Information described in each CITR, and may not be amended except in a writing signed by a duly authorized representative of the respective parties. Any other agreements between the parties, including non-disclosure agreements, will not be affected by this Agreement.
   (f) The disclosing party disclaims all warranties regarding all Confidential Information disclosed pursuant to this Agreement, including all warranties as to the accuracy or utility of such Confidential Information.

INTEL CONTACT: Bill deDiego M/S: SC2-07 TEL. NO: 408-765-9236

AGREED:
INTEL CORPORATION
2200 Mission College Blvd.
Santa Clara, CA 95052-8119

SEAN MALONEY
VICE PRESIDENT
DIRECTOR, SALES AND MARKETING
FOR NON USE ONLY

PARTICIPANT: GEL-PAK LLC
(Company Name, Division/Sub, if applicable)
756 N. PASTORIA
(Street Address)
SUNNYVALE CA 94086
(City) (State) (Zip)
Signature of Authorized Representative (e.g. President or V.P.)
JAMES A. BLY CFO & VP
Printed Name & Title

NOTE: TO ENABLE QUICK EXECUTION, INTEL HAS PRE-SIGNED THIS STANDARD CNDA. ANY MODIFICATIONS TO THIS CNDA WILL RENDER THIS CNDA AND INTEL'S SIGNATURE NULL AND VOID.

PLEASE SEND THIS COPY TO: INTEL CORPORATION, ATTN: POST CONTRACT MGMT, FM4-03, 1900 PRAIRIE CITY RD., FOLSOM, CA 95630 (ASMO) OR TO YOUR INTEL CONTACT (EMEA)

03/00

AGREEMENT DATE: Wednesday, May 10, 2000 CNDA# 7504006

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AGREED:
INTEL CORPORATION
2200 Mission College Blvd.
Santa Clara, CA 95052-8119

Sean Maloney

SEAN MALONEY
VICE PRESIDENT
DIRECTOR, SALES AND MARKETING

FOR NDA USE ONLY

PARTICIPANT: International Test Solutions Inc.
(Company Name, Division/Sub, if applicable)

2479 Chardonnay Way
(Street Address)

Livermore CA 94550
(City) (State) (Zip)

Alan E Humphrey
Signature of Authorized Representative (e.g., President or V.P.)

Alan E. Humphrey, President, C.O.O.
Printed Name & Title

NOTE: TO ENABLE QUICK EXECUTION, INTEL HAS PRE-SIGNED THIS STANDARD CNDA. ANY MODIFICATIONS TO THIS CNDA WILL RENDER THIS CNDA AND INTEL'S SIGNATURE NULL AND VOID.

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03/00

EXHIBIT D

US006777966B1

(12) **United States Patent**
Humphrey et al.

(10) **Patent No.: US 6,777,966 B1**
(45) **Date of Patent: Aug. 17, 2004**

(54) **CLEANING SYSTEM, DEVICE AND METHOD**

(75) Inventors: **Alan E. Humphrey**, Livermore, CA (US); **Billie Jean Freeze**, Livermore, CA (US)

(73) Assignee: **International Test Solutions, Inc.**, Livermore, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 208 days.

(21) Appl. No.: **09/624,750**

(22) Filed: **Jul. 24, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/146,526, filed on Jul. 30, 1999.

(51) **Int. Cl.**[7] **G01R 31/02**; B08B 7/00; B08B 3/14; A47L 11/00; A47L 11/32

(52) **U.S. Cl.** **324/757**; 134/6; 134/42; 15/4; 15/97.1

(58) **Field of Search** 324/754, 757, 324/758, 761, 765; 134/6, 22.1, 22.11, 18, 42; 15/4, 21.1, 97.1, 104.002, 104.93

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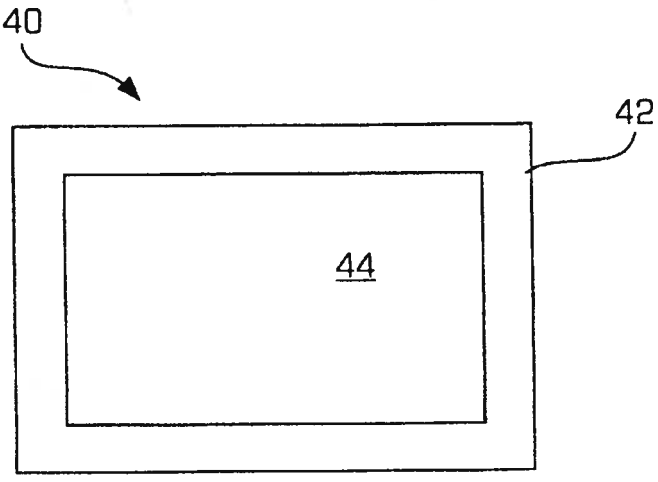
Primary Examiner—Kamand Cuneo
Assistant Examiner—Jermele Hollington
(74) *Attorney, Agent, or Firm*—Gray Cary Ware & Freidenrich LLP

(57) **ABSTRACT**

The cleaning device may clean probe elements. The probe elements may be the probe elements of a probe card testing apparatus for testing semiconductor wafers or semiconductor dies on a semiconductor wafer or the probe elements of a handling/testing apparatus for testing the leads of a packaged integrated circuit. During the cleaning of the probe elements, the probe card or the handler/tester is cleaned during the normal operation of the testing machine without removing the probe card from the prober. The cleaning device may be placed within the prober or tester/handler similar to a wafer containing semiconductor dies to be tested so that the probe elements of the testing machine contact the cleaning medium periodically to remove debris and/or reshape the tips of the probe elements. The cleaning device may include a substrate, that may be shaped and sized like a typical semiconductor wafer that typically fits into the testing machine, and a pad attached to the upper surface of the substrate that cleans and/or reshapes the probe element tips without removing the testing head with the probe elements from the testing machine. The cleaning medium may chemically clean the probe elements and trap the environmentally hazardous material within and on the pad.

28 Claims, 5 Drawing Sheets



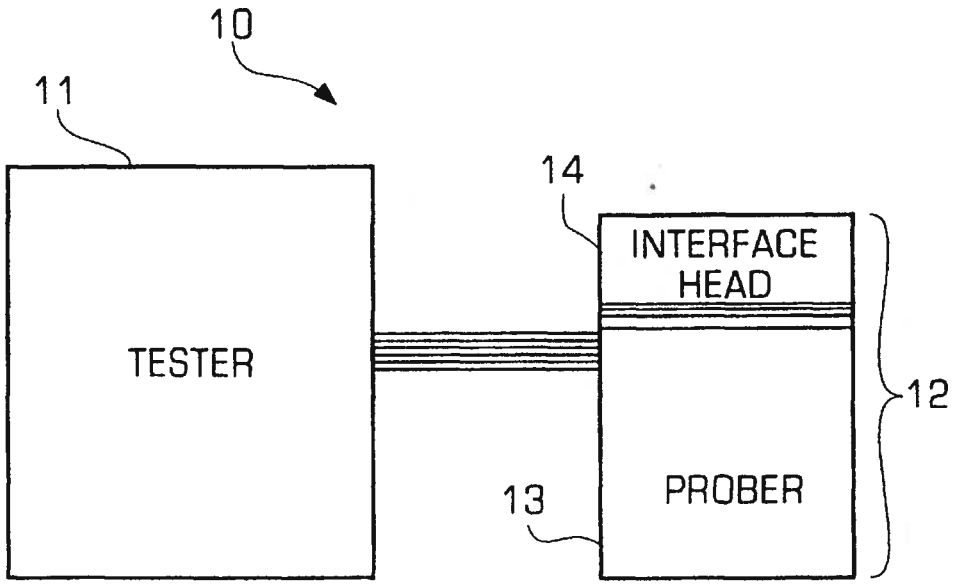


FIGURE 1

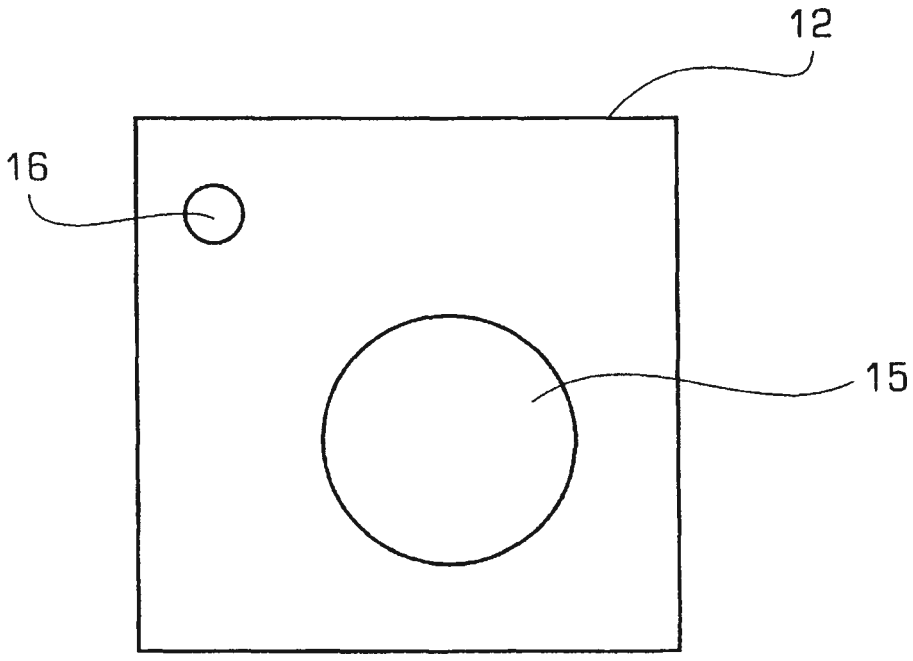


FIGURE 2

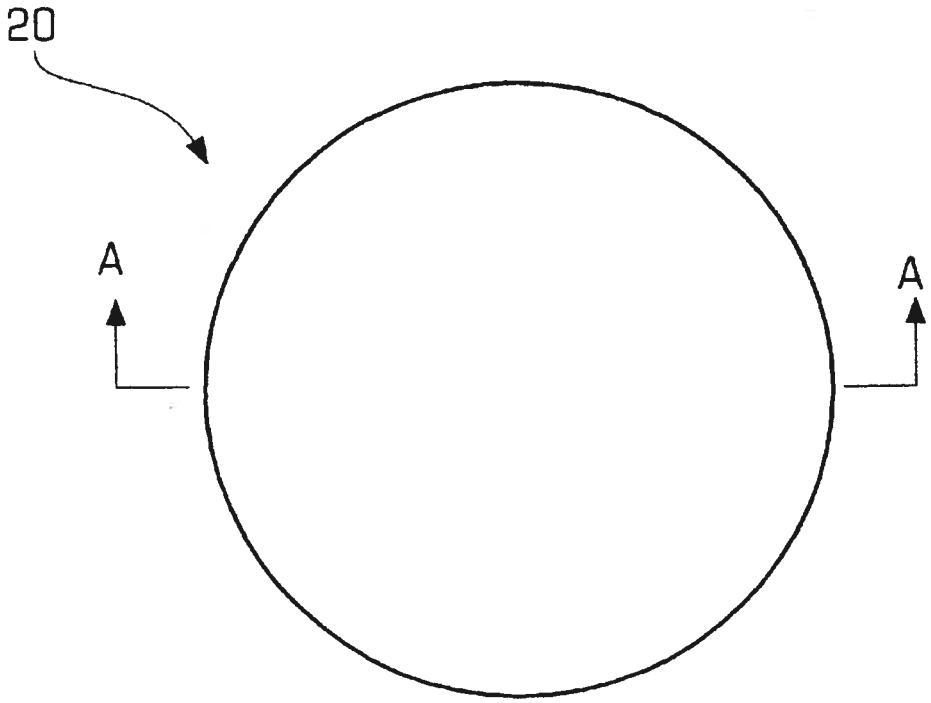


FIGURE 3

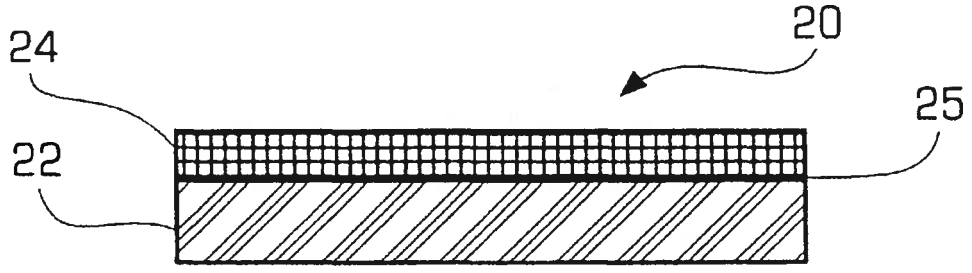


FIGURE 4

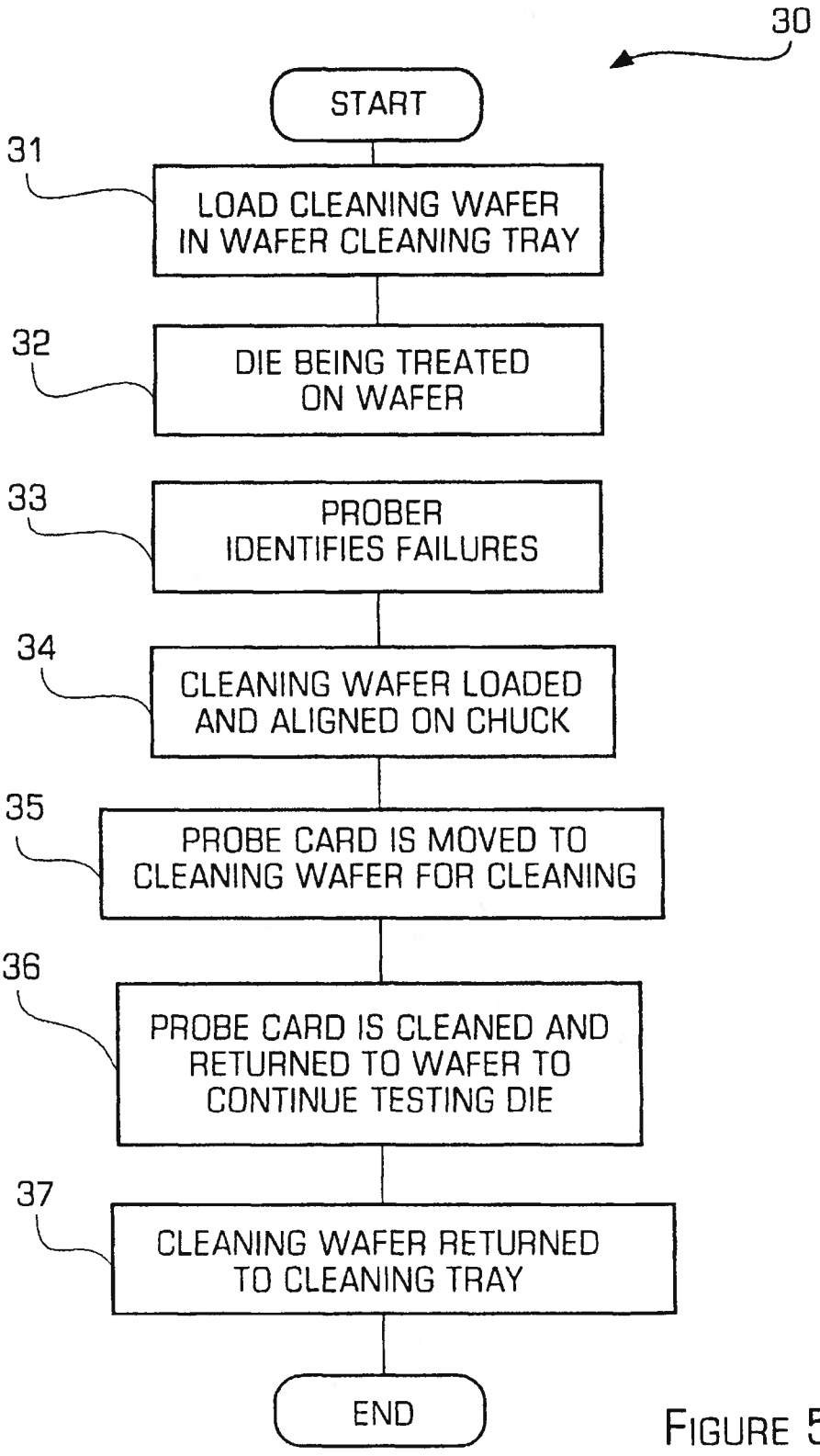

30
START
31
LOAD CLEANING WAFER IN WAFER CLEANING TRAY
32
DIE BEING TREATED ON WAFER
33
PROBER IDENTIFIES FAILURES
34
CLEANING WAFER LOADED AND ALIGNED ON CHUCK
35
PROBE CARD IS MOVED TO CLEANING WAFER FOR CLEANING
36
PROBE CARD IS CLEANED AND RETURNED TO WAFER TO CONTINUE TESTING DIE
37
CLEANING WAFER RETURNED TO CLEANING TRAY
END

FIGURE 5

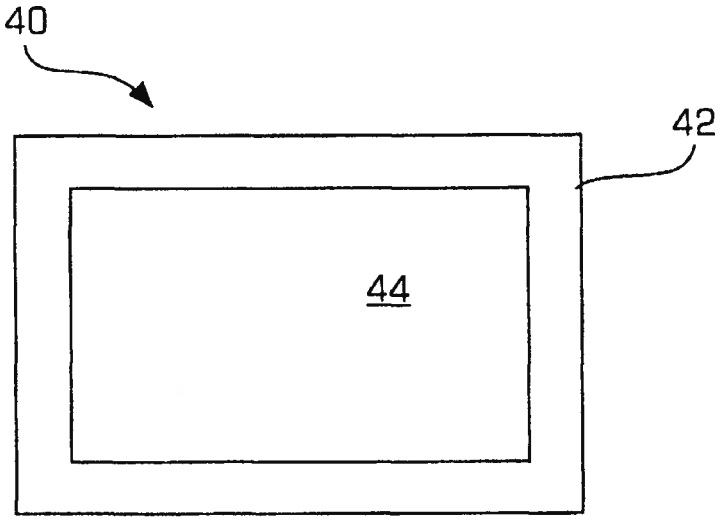


FIGURE 6A

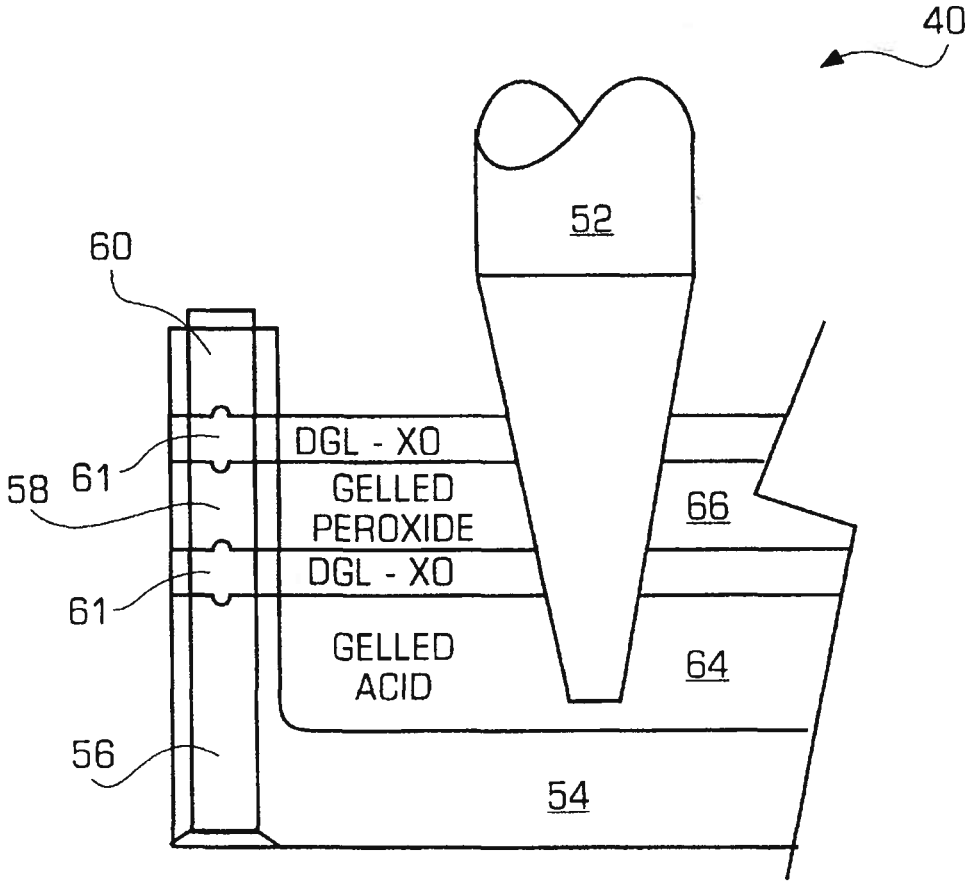


FIGURE 6B

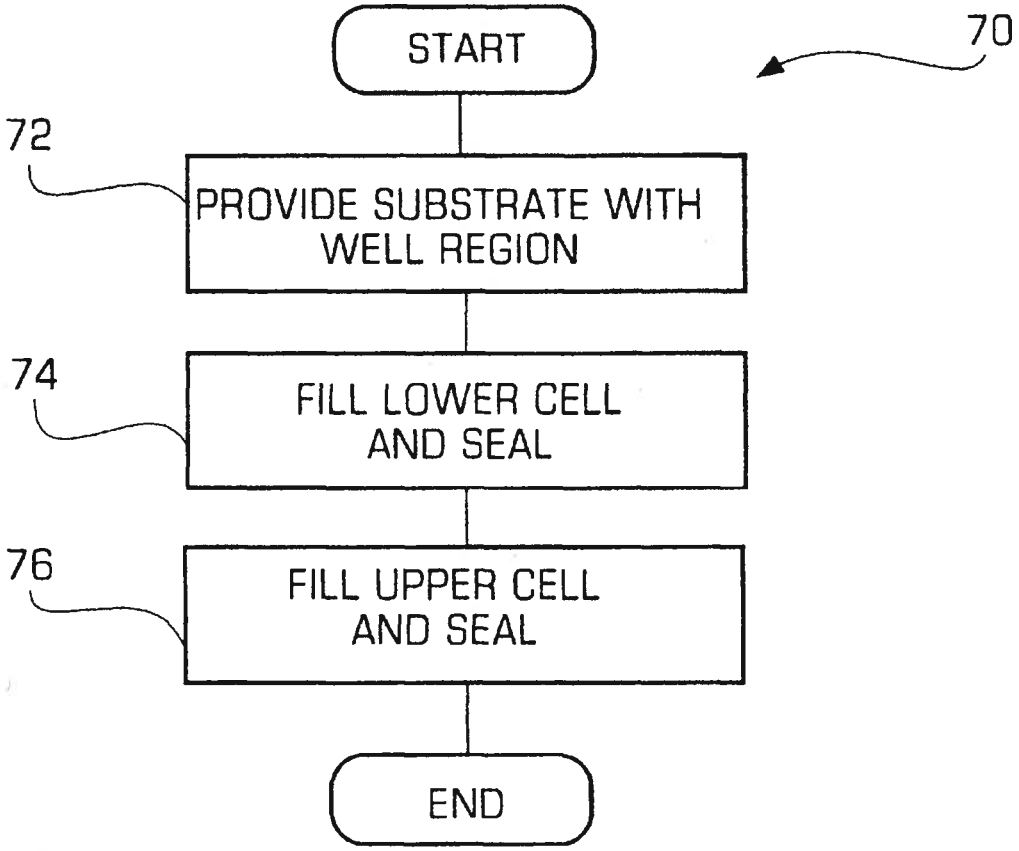

START
70
72
PROVIDE SUBSTRATE WITH WELL REGION
74
FILL LOWER CELL AND SEAL
76
FILL UPPER CELL AND SEAL
END

FIGURE 7

CLEANING SYSTEM, DEVICE AND METHOD

RELATED CASES

This application claims priority from U.S. Provisional Patent Application No. 60/146,526 filed Jul. 30, 1999 and the provisional application is incorporated herein.

BACKGROUND OF THE INVENTION

This invention relates generally to a medium for cleaning a manual test interface while it is still in the prober. This manual interface is generally referred to as a probe card, which is used in the prober to make an electrical connection between the die on a silicon wafer and the tester so that the functionality of the die may be evaluated.

Currently, the method for cleaning the probe card is to remove it from the prober and manually clean the debris from the probe tips. The probe tips need to be cleaned to remove debris from them since the debris reduces the quality of the electrical circuit completed by the contact of the probe tips to any surfaces on a die. The completed electrical circuit is used to evaluate the electrical characteristics of the die by the test apparatus. The degradation of the quality of the electrical circuit caused by the probe tip debris may be interpreted by the test apparatus as a failure of the die under test even though the die is functioning correctly. This false failure of the die results in the rejection or the rework of good die thereby increasing the cost of the final products sold. In the industry, it has been seen that a 1% change in yield from an individual prober can equate to more than $1,000,000 per annum. Therefore, with thousands of probers operating worldwide, the impact to the industry from maintaining clean probes during testing can be very substantial.

Individual semiconductor (integrated circuit) devices are typically produced by creating multiple devices on a silicon wafer using well known semiconductor processing techniques including photolithography, deposition, and sputtering. Generally, these processes are intended to create multiple, fully functional integrated circuit devices prior to separating (singulating) the individual devices (dies) from the semiconductor wafer. However, in practice, physical defects in the wafer material and defects in the manufacturing processes invariably cause some of the individual devices to be non-functional, some of which may be repairable. It is desirable to identify the defective devices prior to separating or cutting the dies on the wafer. In particular, some product is actually repairable when the flaws are caught at the wafer lever. Other product may not be repairable but may be used in a downgraded application from the original product. This determination of the product's capabilities (a product definition provided by electrical probe testing) at the wafer level saves the manufacturer considerable cost later in the manufacturing process. In addition, product cost may be reduced if defective devices are identified.

To enable the manufacturer to achieve this testing capability a probe card, prober and tester are employed to make temporary electrical connections to the bonding pads, solder or gold bumps or any surface on the chip where connection can be made by making manual contact to that surface. The surface may be on the individual circuit device or on multiple circuit devices when the devices are still part of a wafer. Once the connections between the tester and the circuit device are made, power and electrical signals are transferred from the tester to the device for testing, to determine its functionality and to identify its acceptance or

rejection for further processing. Typically, the temporary connections to the device bonding elements are made by contacting multiple electrically conductive probes (needle like structures) against the electrically conductive bonding elements of the device. By exerting controlled pressure (downwards force on the bonding pads) of the probe tips against the bonding pads, a satisfactory electrical connection is achieved allowing the power, ground and test signals to be transmitted.

The tester and prober need a manual interface to the bonding elements on the die to achieve contact. A probe card having a plurality of probes is used to make the connection with the bonding pads of the semiconductor die. The probes may be cantilever beams or needles or vertical beams. Typically, each probe is an inherently resilient spring device acting as a cantilever beam, or as an axially loaded column. A variation is to mount multiple probes in a spring-loaded support. In a conventional prober, the probe card, and its multiple probes, are held in precise mechanical alignment with the bonding elements of the device under test (or multiple devices, or wafer as the case may be) and the device is vertically translated into contact with the tips of the probes. In the typical prober, the tips of the probes may perform a scrubbing action in which the tip of the probes moves horizontally as it contacts the bonding pad in order to scrub away oxide, or any other material on the pad, that may inhibit the electrical contact between the probes and the bonding pads. Although the scrubbing action improves the electrical contact between the probe tip and the bonding pad, it unfortunately also generates some debris (the scraped up oxide or other debris) that may also prevent the probe tip from making a good electrical contact with the bonding pad. Alternatively, the probe tip may press vertically into the bonding pad, solder or gold bump with sufficient force to penetrate any surface material and establish good electrical contact. The probe tip may become contaminated with contaminates such as aluminum, copper, lead, tin or gold.

Typically, the debris generated by probing needs to be periodically removed from the probe elements to prevent a build-up which causes increased contact resistance, continuity failures and false test indications, which in turn results in artificially lower yields and subsequent increased product costs. Typically, the entire probe card with the plurality of probes must be removed from the prober and cleaned or abrasively cleaned in the prober. In a typical prober, the probe card is cleaned as often as several times an hour.

The process of cleaning in the prober using an abrasive pad burnishes the tips but it does not remove the debris. The burnishing actually causes wear to the probe card by shortening the probe tips. In addition, since it does not remove the debris, and since the debris exhibits a slight electrical charge, it attracts more debris so the probe card will require cleaning more often than the original clean card. Currently the debris from burnishing can be removed manually by means of alcohol and a cotton tip swab or an air gun. Each method cleans the probes but requires stopping the prober and a person to perform the function.

Other contaminates, such as lead and tin, may be removed by abrasive cleaning/burnishing or cleaning the probes with a solution that may typically be an acid for example. When probe cards which have collected lead and tin are burnished, particulates of lead are released into the air that cause environmental hazards. In addition, the acid solution requires a separate, rather expensive machine that sprays the solution onto the tips in a closed chamber. These typical cleaning processes are expensive since the tester will have down time and a replacement card must be purchased to run

while the other probe card is being cleaned. In addition the equipment and manual labor adds additional costs to the task performed.

It is desirable to provide a probe card cleaning device and method which overcomes the above limitations and drawbacks of the conventional cleaning devices and methods so that the probe cards may be cleaned more rapidly and effectively while in the prober and it is to this end that the present invention is directed. The cleaning device and method may also be used with other devices.

SUMMARY OF THE INVENTION

In accordance with the invention, a cleaning medium is provided that will clean the probes of a probe card without removing the probe card from the prober. In particular, the cleaning medium may be placed within the prober similar to a wafer being tested so that the probes of the probe card contact the cleaning medium periodically to remove debris and/or contaminates from the probes. In a preferred embodiment, the cleaning medium may include a substrate that may be shaped like a typical semiconductor wafer that typically fits into the prober. The substrate may also be a ceramic plate or any type of substrate, which can fit over or replace the abrasive plate in the prober. The pad may have predetermined mechanical and/or chemical characteristics, such as abrasiveness, density, elasticity, tackiness, planarity, and/or chemical properties, such as being acetic or basic, so that when the probe tips contact the pad surface, the tips of the probes are cleaned and the debris and contaminates are removed from the tips. In another embodiment, the pad may be made of a material so that the probe tips may penetrate into or through the pad, which cleans the debris from the tips. In a preferred embodiment, the substrate may be a semiconductor wafer, ceramic, or any material to which the cleaning pad will attach. In another embodiment, the physical properties of the pad, such as density and abrasiveness, may be predetermined so as to clean the probe element and remove bonded or embedded debris from the probe elements without causing significant damage to the probe elements. In another embodiment, the physical properties of the pad, such as density and abrasiveness, may be predetermined so as to shape or reshape the probe elements during probing on or into the medium.

Thus, in accordance with the invention, a cleaning medium for cleaning probe elements in a semiconductor testing apparatus is provided wherein the cleaning medium comprises a substrate having a configuration to be introduced into the testing apparatus during normal testing operation, and a pad, secured to the substrate. The pad has predetermined characteristics, which clean debris from the probe elements and maintain or modify the shape of the probe element when the elements contact or penetrate into or through the pad.

In accordance with another aspect of the invention, a method for cleaning the probe elements on a prober or an analyzer is provided wherein the method comprises loading a cleaning medium into the prober, the cleaning medium having the same configuration as the wafers with the semiconductor dies normally tested by the testing apparatus and the cleaning medium having a top surface with predetermined properties, such as abrasiveness, tack, hardness, that clean the probes. The method further comprises contacting the probe elements with the cleaning medium during the normal testing operation in the prober so that any debris is removed from the probe elements during the normal operation of the prober or analyzer.

In accordance with another aspect of the invention, a method for maintaining or modifying the shape of the probe elements on a prober or an analyzer is provided wherein the method comprises loading a cleaning medium into the prober or analyzer, the medium having varying density, tack, abrasiveness or other physical characteristics which are optimized for various probe elements of the probe cards.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of an automated testing system that may include the cleaning device in accordance with the invention;

FIG. **2** is a top view of the automated testing system of FIG. **1**;

FIG. **3** is a top view of a cleaning device in accordance with the invention;

FIG. **4** is a sectional view taken along line A—A in FIG. **3** of the cleaning device in accordance with the invention;

FIG. **5** is a flowchart illustrating a method for cleaning a probe tip in accordance with the invention;

FIGS. **6**A and **6**B are diagrams illustrating another embodiment of the cleaning device in accordance with the invention; and

FIG. **7** is a flowchart illustrating a method for manufacturing the cleaning device shown in FIGS. **6**A and **6**B.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The invention is particularly applicable to a cleaning medium for cleaning the probes in a prober and it is in this context that the invention will be described. It will be appreciated, however, that the device and method in accordance with the invention has greater utility, such as cleaning other types of semiconductor processing equipment. The cleaning method can also be used on an analyzer which is a metrology tool used in the routine maintenance of probe cards.

FIGS. **1** and **2** are diagrams illustrating a testing system **10** that may be cleaned using the cleaning medium in accordance with the invention. In particular, the system **10** may include a tester **11** electrically connected to a prober machine **12** that may actually apply the probes to the semiconductor wafer or die and test them. The prober machine **12** may further include a prober **13** and an interface head **14** as shown in FIG. **1**. The prober machine **12** may also have an abrasion/sanding disk **16**, which is typically used to burnish the probe tips, as shown in FIG. **2**. The prober machine **12** may also include a prober chuck **15** that moves the wafers/dies during the testing process. Instead of the typically removing the prober **13** in order to clean the probe elements, the cleaning device in accordance with the invention permits the probe elements to be cleaned while the prober is operating. In particular, a cleaning wafer cassette containing the cleaning device in accordance with the invention may be introduced periodically into the testing system in accordance with the invention. Alternatively, a cleaning device in accordance with the invention may be loaded into each cassette with other wafers being tested so that the probe elements are cleaned each time a cassette of wafers is tested. Thus the cleaning medium will clean the probe needles during the normal testing operation of the prober. Now the cleaning medium in accordance with the invention will be described in more detail.

FIGS. **3** and **4** are diagrams illustrating a cleaning device **20** in accordance with the invention. As shown in FIG. **4**, the

cleaning device **20** may include a substrate **22** and a pad **24** secured or adhered to a surface **25** of the substrate. The substrate may be any material that can support the pad and has sufficient strength to resist breaking when the probes come into contact with the pad and generate a contact force. Thus, the substrate may be plastic, metal, glass, silicon, ceramic or any other similar material. In a preferred embodiment, the substrate **22** may be a semiconductor wafer. The wafer surface **25** onto which the pad is secured or adhered may have a flat mirror finish or a slightly abrasive roughness finish with microroughness of about 1–3μm. The abrasive finish may burnish/abrade the probe tips during the cleaning process.

The pad **24** may be made of a material with predetermined properties that contribute to the cleaning of the probe elements tips that contact the pad. For example, the pad may have abrasive, density, elasticity, and/or tacky properties that contribute to cleaning the probe tips. The abrasiveness of the pad will loosen debris from the scrubbing action and remove unwanted material from the tips. Using a more dense material, the abrasiveness of the pad may round or sharpen the probe tips. Typical abrasives that may be used include aluminum oxide, silicon carbide, and diamond although the abrasive material may also be other well known abrasive materials. The tackiness of the pad may cause any debris on the probe tip to preferentially stick to the pad and therefore be removed from the probe tip. In a preferred embodiment, the pad may be made of an elastomeric material that may include rubbers and both synthetic and natural polymers. The elastomeric material may be a material manufactured with a slight tackiness or some abrasive added to the body of the material. The material may have a predetermined elasticity, density and surface tension parameters that allow the probe tips to penetrate the elastomeric material and remove the debris on the probe tips without damage to the probe tip, while retaining the integrity of the elastomeric matrix. In the preferred embodiment, the elastomeric material may be Gel-Pak LLC "GEL" membrane with a thickness of the elastomeric material being generally between 1 and 20 mils thick. The thickness of the pad may be varied according the specific configuration of the probe tip.

As the one or more probe elements of the prober contact the pad during the normal operation of the prober machine, they exert a vertical contact force to drive the probe element into the pad where the debris on the probe elements will be removed and retained by the pad material. The amount and size of the abrasive material added to the elastomer may vary according the configuration and material of the probe elements to achieve a pad, which will remove the debris but will not damage the probe elements. The pad material and abrasiveness may vary in the manufacturing of a pad used to reshape or sharpen the probe element tips. The same cleaning and reshaping may also be accomplished by the substrate alone. Now, a method for cleaning a plurality of probe elements in accordance with the invention will be described.

FIG. **5** is a flowchart illustrating a method **30** for cleaning a plurality of probes in accordance with the invention. The method accomplishes the goal of removing the debris from the probe tips without removing the probe card from the prober, which increases the productivity of the tester. In step **31**, the cleaning device, that may have the same size and shape as typical wafers containing the dies being tested by the tester, may be inserted into a wafer cleaning tray. In accordance with the invention, the cleaning medium may be located in the wafer cleaning tray or one or more cleaning pads may be inserted into one or more cassettes that also contain wafers with semiconductor devices to be tested so that, as each cassette is run through the tester, the cleaning device in the cassette cleans the probe elements. In step **32**, the tester is operated and tests the semiconductor dies on the wafers. In step **33**, the prober identifies a predetermined number of failures in the dies being tested which indicates that the prober element's may be dirty. In step **34**, the cleaning device in accordance with the invention (a wafer) is loaded and aligned with the chuck. In step **35**, the probe elements in the tester contact the cleaning device so that the debris is removed from the probe elements or the tips of the probes may be reshaped. As described above, this cleaning step may occur either when the cleaning device is periodically installed from the wafer cleaning tray into the prober or every time from the wafer cassette, or anytime the prober cleans the probe card on the burnishing plate. In step **36**, the cleaning is completed and the prober returns to testing the die and wafers. In step **37**, the cleaning wafer is returned to the cleaning tray so that the prober machine can continue to test dies. In accordance with the invention, the cleaning device does not interrupt, in any way, the operation of the prober since the cleaning of the probes is accomplished during the normal operation of the testing machine. In this manner, the cleaning device is inexpensive and permits the probe to be cleaned and/or shaped without removing the probe card from the prober. Now, another embodiment of the cleaning device in accordance with the invention will be described.

FIGS. **6**A and **6**B are diagram illustrating a second embodiment of a cleaning device **40** in accordance with the invention. In more detail, the cleaning device **40** may include one or more different layers of material which may clean or sharpen the probe elements as will now be described. Thus, in accordance with this embodiment of the invention, the cleaning pad may be placed on a substrate for use on the abrasive plate in the prober, the prober chuck, analyzer or any other machine. As shown in FIG. **6**A, the cleaning device **40** may include a frame **42** that encloses one or more layers of chemical cells **44**. The layers in the cleaning device may be made of a material which exhibits acetic or basic chemical properties which may be used to oxidize and/or reduce contaminates on the probe tips. The layers may also be made of materials that induce chemical reactions and/or mechanical actions that remove such contaminates. The removal of the contaminates, such as heavy metals, that may be environmentally hazardous will be trapped on or in the pad so that they will not be dispersed into the air. This embodiment will now be described in more detail with reference to FIG. **6**B.

FIG. **6**B is a diagram illustrating a second embodiment of a cleaning device **40** in accordance with the invention with a probe needle **52** inserted into the layers of the cleaning device in order to clean the probe needle. In more detail, the cleaning device may have a shape of a typical wafer so that it may be used in-line and may further include one or more different layers of material. In particular, the cleaning device **40** may include a substrate **54** having a wall wherein the wall may be constructed of several pieces made of chemically resistant material. The walls may include a bottom portion **56**, a middle portion **58** and an upper portion **60** stacked on top of each other with a layer of elastomeric material **61** in between the portions of the wall. The walls of the substrate form a well region into which one or more different layers of chemicals may be placed and these chemicals may etch away materials struck onto the probe needles. A first bottom well **64** of the substrate may be filled with an acid matrix such as acetic acid, as described with reference to FIG. **7** and sealed into the well by a layer **61** of elastomeric material.

The chemical matrix may consist of chemicals in any form, solid, liquid, gas, or encapsulated, emulsified, saturated, gelled, or the like, provided the amount of chemical induces the desired reaction. Once the seal is in place, the middle portion of the wall **58** may be positioned and secured to the seal by an adhesive, mechanical, thermal, or like methods to form a second well **66**. In the second well **66**, a peroxide mixture that gels is placed into the well as described in more detail with reference to FIG. **7**, and sealed by a sealing layer **61**. Finally, the upper portion **60** is secured to the top seal layer to form the cleaning device in accordance with the invention.

During the cleaning operation, the probe needle **52** may penetrate through the two seal layers **61** and thus extend into the acid and peroxide matrix layers in the wells. The acid and peroxide may react with the contaminates on the probe needle to remove heavy metals and the like. In particular, the acid and peroxide matrix may remove the contaminates from the probe needle and the contaminants may be trapped in the cleaning device by the sealing layers **61**. Now, a method for manufacturing the cleaning device shown in FIGS. **6**A and **6**B will be described.

FIG. **7** is a flowchart illustrating a method **70** for manufacturing the cleaning device **40** shown in FIGS. **6**A and **6**B. In particular, in step **72**, a substrate with a well region is provided. The substrate is typically made of a chemical resistant material such as certain types of plastic. In step **74**, the lower cell of the substrate is filled with the appropriate chemicals and sealed using the elastomeric material. In step **76**, the upper cell of the substrate is filled with the appropriate chemicals and sealed using the elastomeric material. Thus, a two layer cleaning device in accordance with the invention is formed. In accordance with the invention, however, the cleaning device may have any number of different layers of chemicals wherein each different layer may serve a particular function such as removing a different contaminant from the probe element. The above embodiment is typically used for a system that tests the wafers or one or more dies on a semiconductor wafer prior to being encapsulated into a package. Now, another embodiment of the cleaning device will be described wherein the cleaning device may be used for cleaning the probe elements of a handler or a tester that may be used to electrically test the leads of a packaged integrated circuit.

In accordance with another embodiment of the invention, the cleaning device described above may also be used in connection with an handling/testing apparatus that is used to handling and testing integrated circuits (IC) wherein an individual semiconductor die from the wafer described above has been encapsulated into a material, such as plastic. The IC package may have one or more electrical leads extending out from the package that communicate electrical signals, such as a power signal, a ground signal, etc., with the die inside of the package. The testing/handling apparatus may have a plurality of probe elements (similar to the probe card tester described above) that contact the leads of the package and test the electrical characteristics of the packaged IC in a typical manner. Similar to the probe card cleaner embodiment, the cleaning device may be, in a preferred embodiment, a semiconductor shaped substrate with a pad material wherein the probe elements of the handler/tester may contact the pad periodically to remove debris from the tips of the probe elements as described above. The various different materials used for the cleaning device including the multi-layer embodiment may be used with the tester/handler. The size of the cleaning device may be modified slightly to fit the size and shape of the particular tester/handler.

While the foregoing has been with reference to a particular embodiment of the invention, it will be appreciated by those skilled in the art that changes in this embodiment may be made without departing from the principles and spirit of the invention, the scope of which is defined by the appended claims.

What is claimed is:

1. A cleaning device for cleaning the probe elements in a semiconductor testing apparatus, the cleaning device comprising:

a substrate having a configuration to be introduced into the testing apparatus during the normal testing operating of the testing apparatus, wherein the substrate comprises a semiconductor wafer; and

a pad, secured to the substrate, the pad having predetermined characteristics that cause the pad to clean debris from the probe elements when the probe elements contact the pad so that the probe elements are cleaned, without modification or damage, during the normal operation of the testing machine; wherein the pad comprises one or more layers of chemical cleaning agents, which may oxidize and/or reduce contaminates when the probe elements are inserted into the pad and wherein one or more layers comprise a first layer of gelled acid and a second layer of gelled oxidizing agent.

2. The cleaning device of claim **1**, wherein the predetermined characteristics comprise one or more of durometer, tack and elasticity.

3. The cleaning device of claim **1**, wherein the pad comprises a tacky material so that the debris adheres to the pad when the probe elements contact the pad.

4. The cleaning device of claim **1**, wherein the gelled acid comprises acetic acid and the gelled oxidizing agent comprises peroxide.

5. The cleaning device of claim **1**, wherein the pad traps hazardous material, such as lead, on and within the pad when the probe elements are inserted into the pad so that the hazardous materials are not released into the environment.

6. The cleaning device of claim **1**, wherein the pad comprises an elastomeric material that traps and removes the debris from the probe elements within and on the surface of the pad.

7. The cleaning device of claim **6**, wherein the elastomeric material comprises one or more of rubbers, synthetic polymers and natural polymers.

8. The cleaning device of claim **7**, wherein the pad further comprises an abrasive material that maintains the shape of or shapes the tips of the probe elements when the probe elements are driven into and removed from the elastomeric network.

9. A cleaning device for cleaning the probe elements in a semiconductor testing apparatus, the cleaning device comprising:

a substrate having a configuration to be introduced into the testing apparatus during the normal testing operation of the testing apparatus; and

a cleaning pad having one or more layers of chemicals that clean the probe elements and one or more sealing layers that confine the chemical layers and keeps debris removed from the probe elements in the cleaning pad so that the probe elements are cleaned during the normal operations of the testing machine, wherein the one or more layers comprise a first layer of gelled acid and a second layer of gelled oxidizing agent.

10. The cleaning device of claim **9**, wherein the gelled acid comprises acetic acid and the gelled oxidizing agent comprises peroxide.

11. A method for cleaning the probe elements of a testing machine, the method comprising:

loading a cleaning device into the prober, the cleaning device having the same configuration as the wafers with the semiconductor dies normally tested by the testing apparatus, the cleaning device having a top surface with predetermined properties that clean the probe elements; and

contacting the probe elements with the cleaning device during the normal testing operation of the prober so that any debris is removed from the probe elements during the normal operation of the testing machine, the cleaning device having one or more layers of chemicals that clean the probe elements and one or more sealing layers that confine the chemical layers and keeps debris removed from the probe elements in the cleaning pad so that the probe elements are cleaned during the normal operations of the testing machine, wherein the one or more layers comprise a first layer of gelled acid and a second layer of gelled oxidizing agent.

12. The method of claim 11, wherein the loading further comprises periodically loading a cleaning cassette containing one or more cleaning devices into the testing machine when the probe elements are being cleaned.

13. The method of claim 11, wherein the loading further comprises loading one or more cleaning devices into one or more cassettes along with semiconductor wafers having dies being tested by the prober so that the cleaning devices are contacted during the testing process of the die.

14. The method of claim 13, wherein the probe card remains in a cleaned state for a longer period of time increases yield performance increases the amount of revenue for the manufacturer.

15. The method of claim 14, wherein the probe card cleaning device is able to prolong the life of the probe card reduced the number of probe cards the manufacturer is required to purchase in order to have spares.

16. The method of claim 15, wherein less abrasive cleaning is required to be done to the probe card the extended life of the probe card is two to three times longer reducing the amount of probe cards needed to be purchased, increasing savings to the manufacturer.

17. The method of claim 16, wherein the cleaning material properties, such as density and abrasiveness can be selected for any given probe element material or shape to remove embedded or bonded debris without significant damage to the probe element reducing the amount of probe cards needed to be purchased, increasing savings to the manufacturer.

18. A cleaning device for cleaning probe elements comprising:

a substrate having a predetermined configuration appropriate for the particular probe elements, wherein the substrate comprises a semiconductor wafer; and

a pad, secured to the substrate, the pad having predetermined characteristics that cause the pad to clean debris from the probe elements when the probe elements contact the pad so that the probe elements are cleaned, wherein the pad comprises one or more layers of chemical cleaning agents, which may oxidize and/or reduce contaminates when the probe elements are inserted into the pad and wherein one or more layers comprise a first layer of gelled acid and a second layer of gelled oxidizing agent.

19. The cleaning device of claim 18, wherein the predetermined characteristics comprise one or more of durometer, tack and elasticity.

20. The cleaning device of claim 18, wherein the pad comprises a tacky material so that the debris adheres to the pad when the probe elements contact the pad.

21. The cleaning device of claim 18, wherein the gelled acid comprises acetic acid and the gelled oxidizing agent comprises peroxide.

22. The cleaning device of claim 18, wherein the pad traps hazardous material, such as lead, on and within the pad when the probe elements are inserted into the pad so that the hazardous materials are not released into the environment.

23. The cleaning device of claim 18, wherein the pad comprises an elastomeric material that traps and removes the debris from the probe elements within and on the surface of the pad.

24. The cleaning device of claim 23, wherein the elastomeric material comprises one or more of rubbers, synthetic polymers and natural polymers.

25. The cleaning device of claim 24, wherein the pad further comprises an abrasive material that maintains the shape of or shapes the tips of the probe elements when the probe elements are driven into and removed from the elastomeric network.

26. A cleaning device for cleaning the probe elements in a semiconductor testing apparatus, the cleaning device comprising:

a substrate having a configuration to be introduced into the testing apparatus during the normal testing operating of the testing apparatus, wherein the substrate comprises a semiconductor wafer having a surface; and

a pad, secured to the substrate, the pad having predetermined characteristics that cause the pad to clean debris from the probe elements when the probe elements contact the pad so that the probe elements are cleaned, without modification or damage, during the normal operation of the testing machine, wherein the semiconductor wafer surface has microroughness which burnishes the probe elements.

27. A cleaning device for cleaning the probe elements in a semiconductor testing apparatus, the cleaning device comprising:

a substrate having a configuration to be introduced into the testing apparatus during the normal testing operation of the testing apparatus, the substrate comprising a semiconductor wafer having a surface; and

a cleaning pad having one or more layers of chemicals that clean the probe elements and one or more sealing layers that confine the chemical layers and keeps debris removed from the probe elements in the cleaning pad so that the probe elements are cleaned during the normal operations of the testing machine, wherein the semiconductor wafer surface has microroughness which burnishes the probe elements.

28. A cleaning device for cleaning probe elements comprising:

a substrate having a predetermined configuration appropriate for the particular probe elements, wherein the substrate comprises a semiconductor wafer having a surface; and

a pad, secured to the substrate, the pad having predetermined characteristics that cause the pad to clean debris from the probe elements when the probe elements contact the pad so that the probe elements are cleaned, wherein the semiconductor wafer surface has microroughness which burnishes the probe elements.

* * * * *

EXHIBIT E

US007202683B2

(12) **United States Patent**
Humphrey et al.

(10) **Patent No.: US 7,202,683 B2**
(45) **Date of Patent: Apr. 10, 2007**

(54) **CLEANING SYSTEM, DEVICE AND METHOD**

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(73) Assignee: **International Test Solutions**, Reno, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Apr. 16, 2004**

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Related U.S. Application Data

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(60) Provisional application No. 60/146,526, filed on Jul. 30, 1999.

(51) **Int. Cl.**
G01R 31/02 (2006.01)

(52) **U.S. Cl.** **324/757**

(58) **Field of Classification Search** 324/754, 324/757, 758, 761; 134/6, 22.1, 22.11, 18, 134/42; 15/4, 21.1, 97.1, 104.002, 104.93; 451/36, 59, 533–534, 537
See application file for complete search history.

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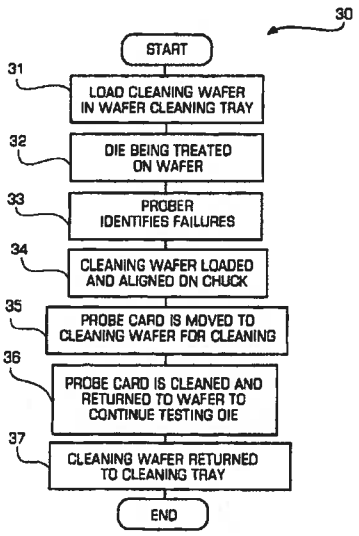
(74) *Attorney, Agent, or Firm*—DLA Piper US LLP

(57) **ABSTRACT**

The cleaning device may clean probe elements. The probe elements may be the probe elements of a probe card testing apparatus for testing semiconductor wafers or semiconductor dies on a semiconductor wafer or the probe elements of a handling/testing apparatus for testing the leads of a packaged integrated circuit. During the cleaning of the probe elements, the probe card or the handler/tester is cleaned during the normal operation of the testing machine without removing the probe card from the prober. The cleaning device has a working surface with a particular characteristic (a matte finish or a conductive material) so that a prober is capable of automatically determining the location of the working surface of the cleaning device and therefore operate in an automatic cleaning mode.

11 Claims, 7 Drawing Sheets



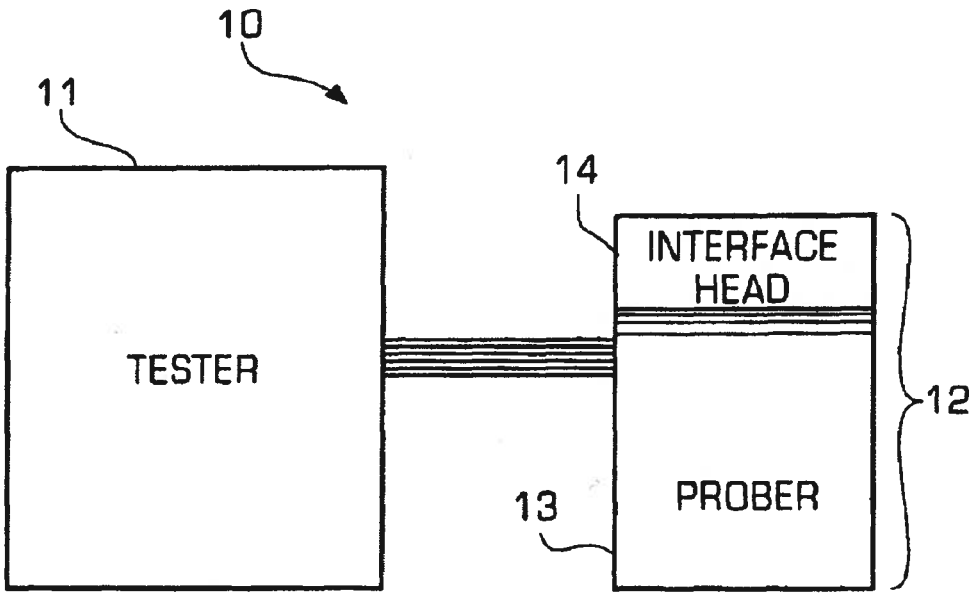


FIG.1

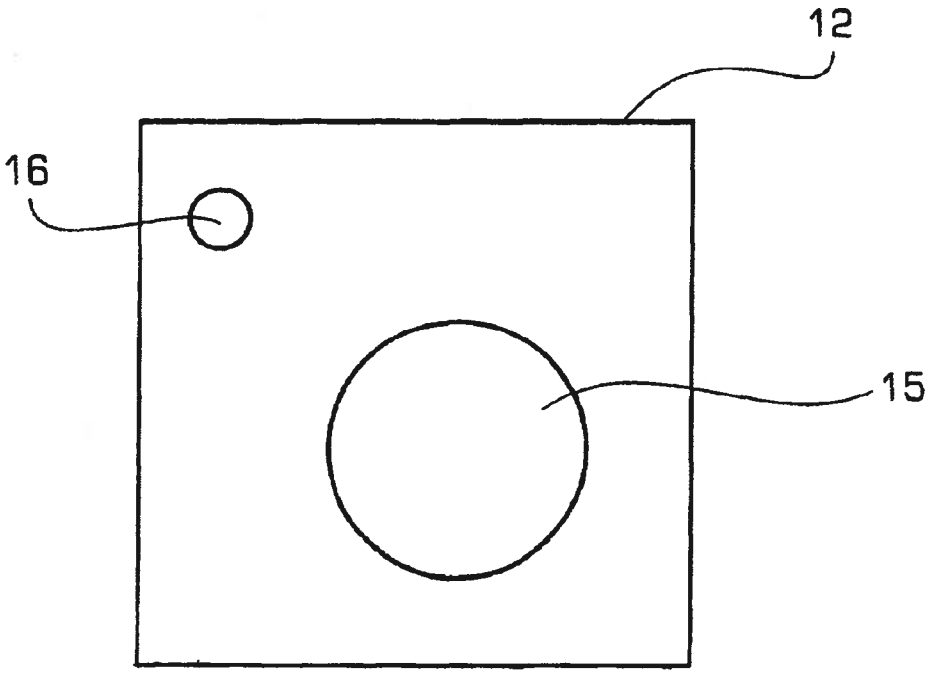


FIG 2

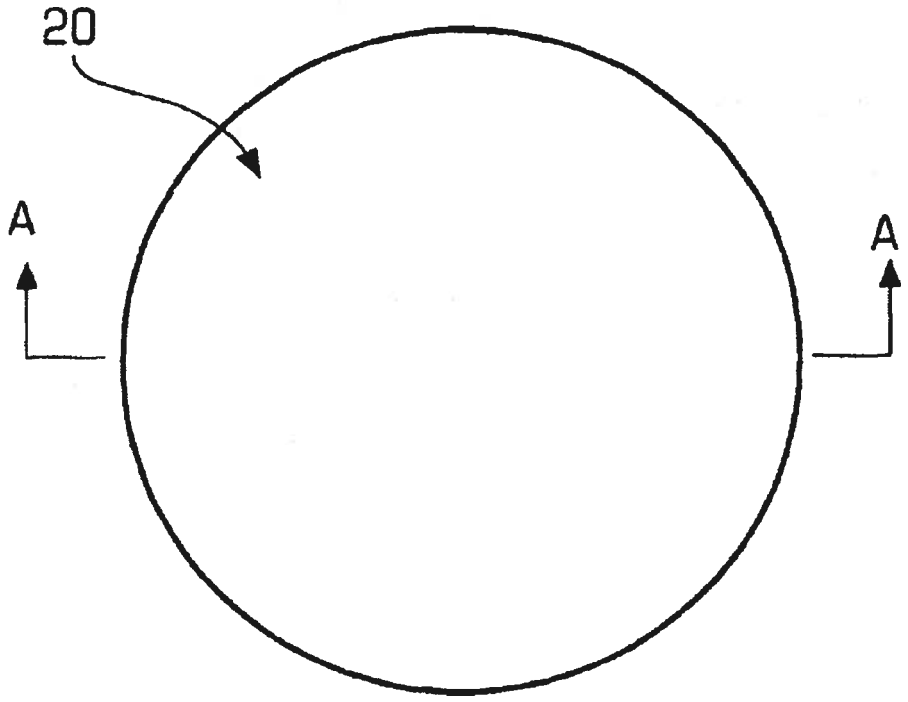


FIG. 3

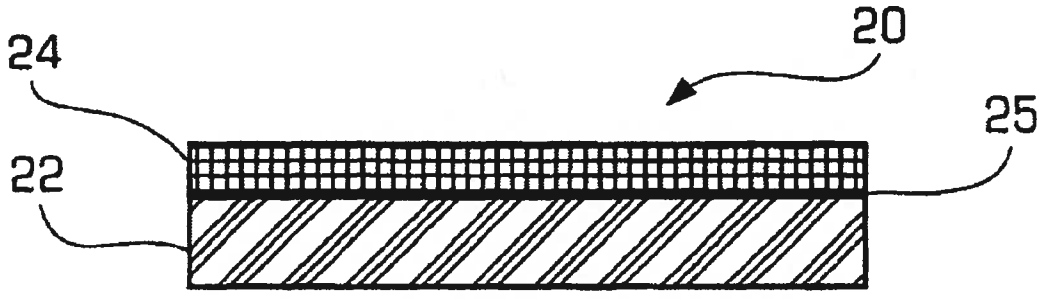
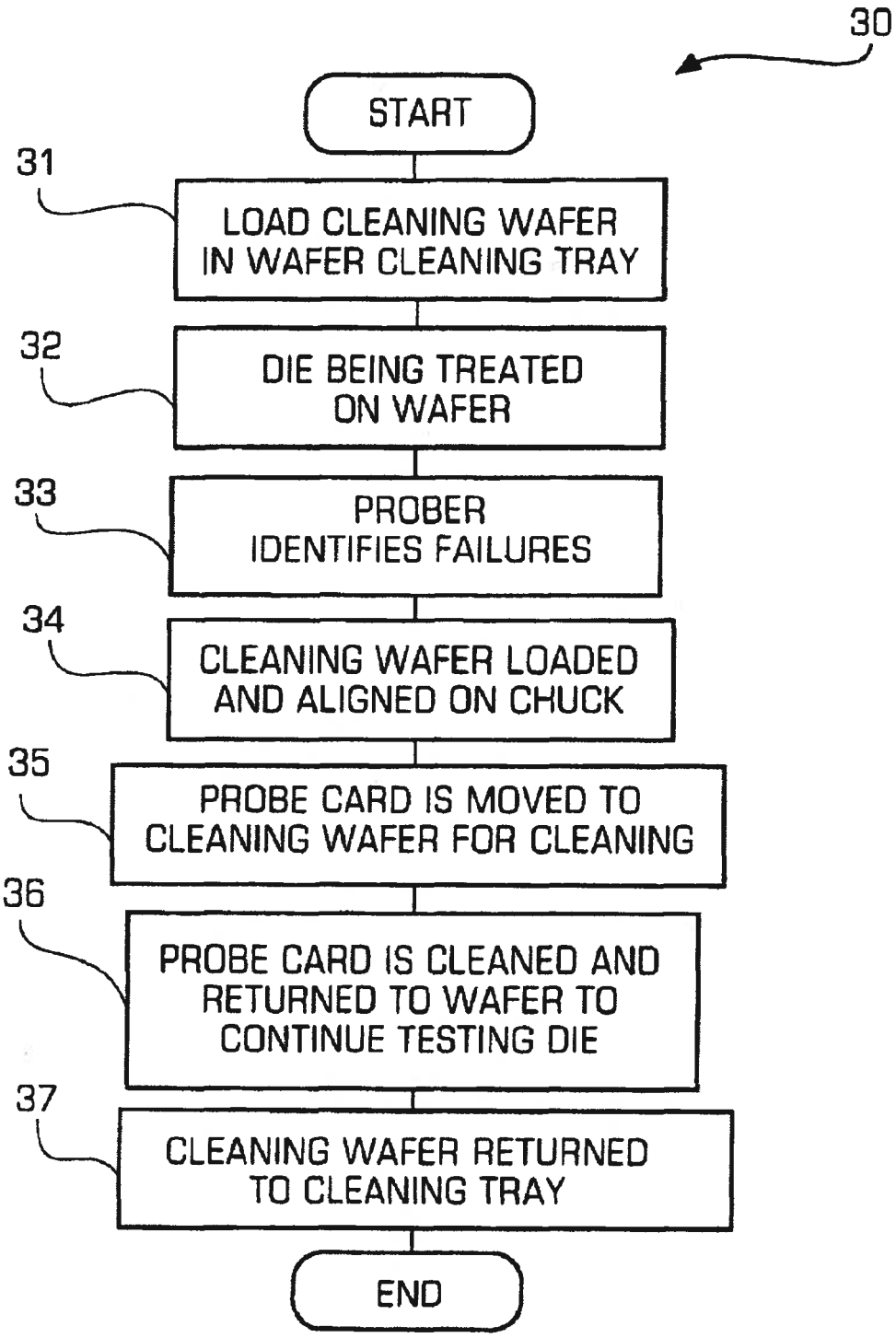


FIG. 4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START
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LOAD CLEANING WAFER IN WAFER CLEANING TRAY
32
DIE BEING TREATED ON WAFER
33
PROBER IDENTIFIES FAILURES
34
CLEANING WAFER LOADED AND ALIGNED ON CHUCK
35
PROBE CARD IS MOVED TO CLEANING WAFER FOR CLEANING
36
PROBE CARD IS CLEANED AND RETURNED TO WAFER TO CONTINUE TESTING DIE
37
CLEANING WAFER RETURNED TO CLEANING TRAY
END

FIG. 5

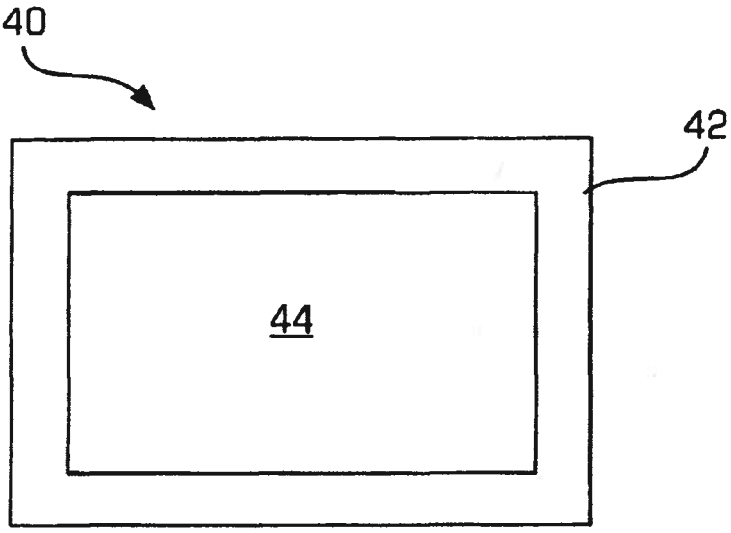
40
42
44

FIG. 6A

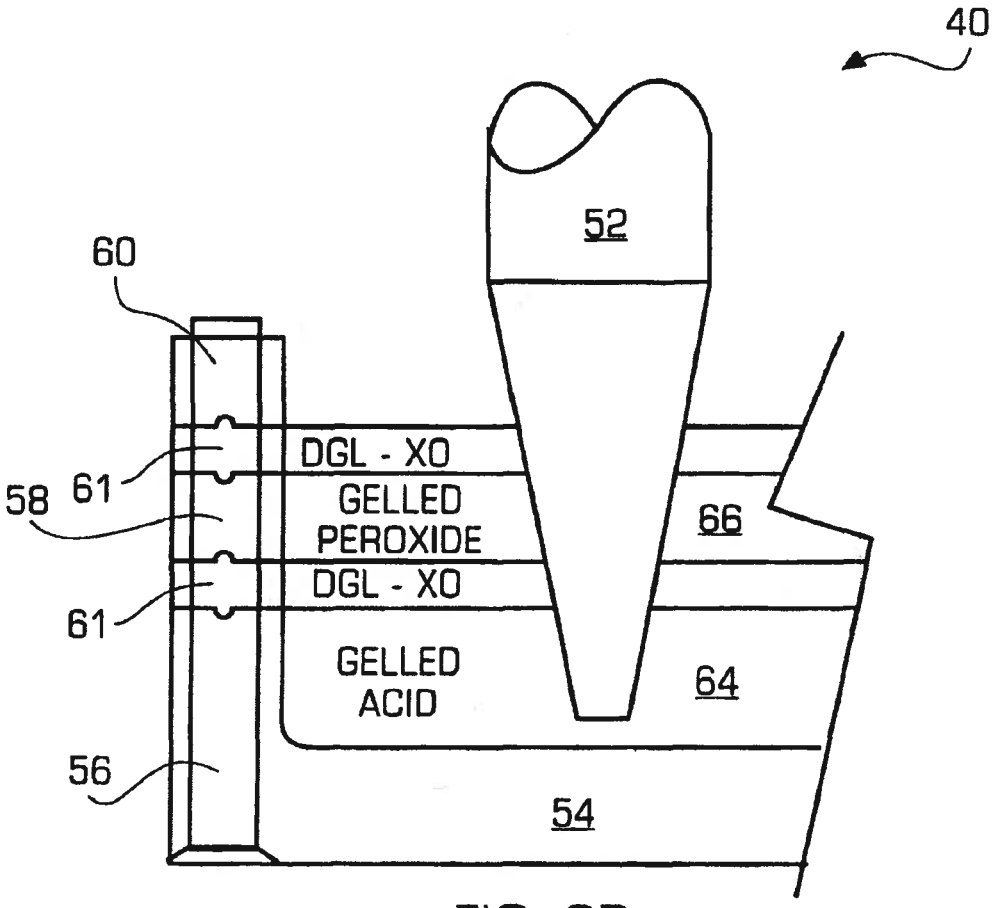
40
52
60
58
61
DGL - XO
GELLED PEROXIDE
66
DGL - XO
61
GELLED ACID
64
56
54

FIG. 6B

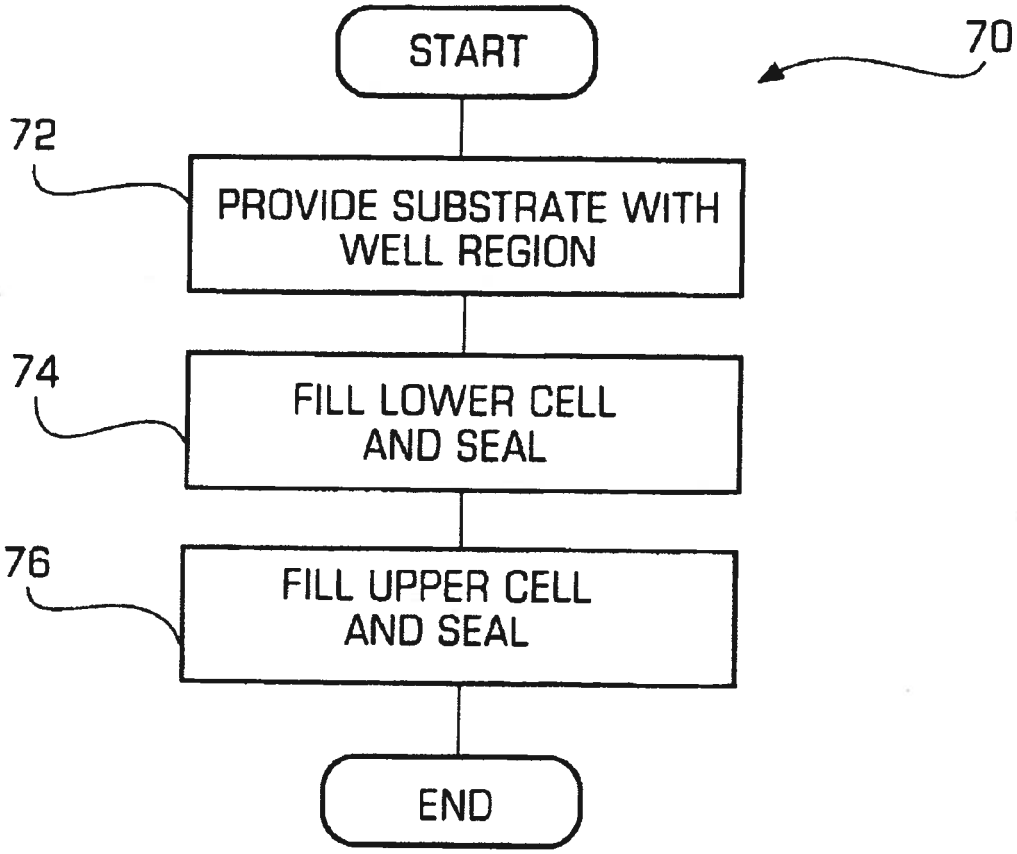
START
70
72
PROVIDE SUBSTRATE WITH WELL REGION
74
FILL LOWER CELL AND SEAL
76
FILL UPPER CELL AND SEAL
END

FIG. 7

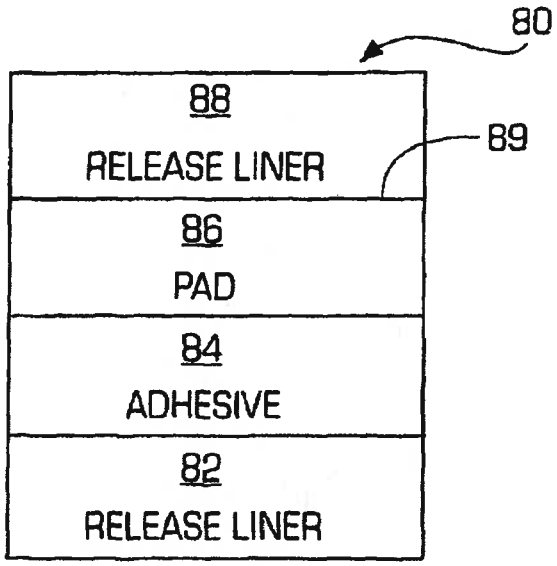

FIG. 8A

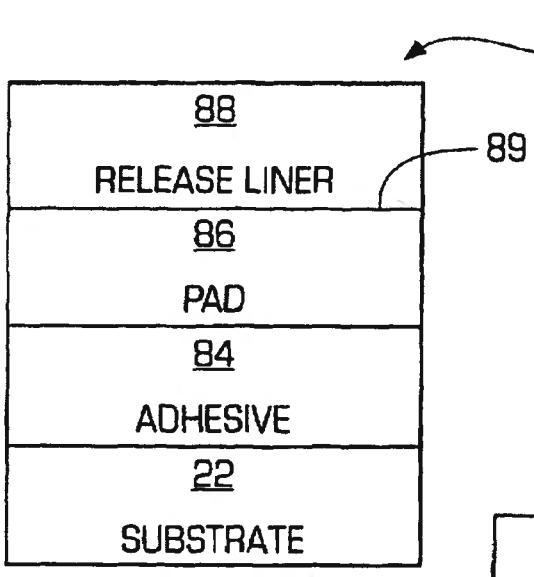

FIG. 8B

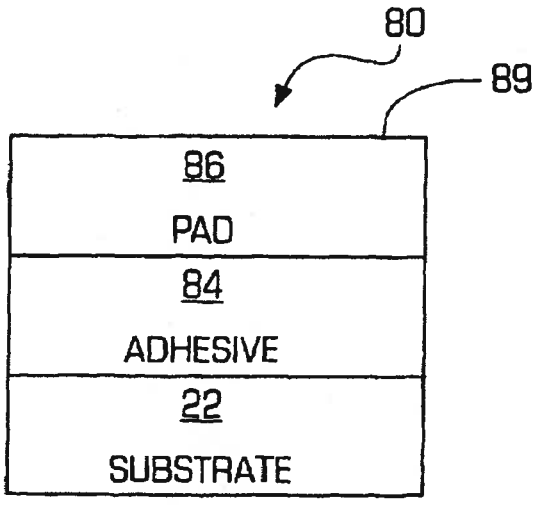

FIG. 8C

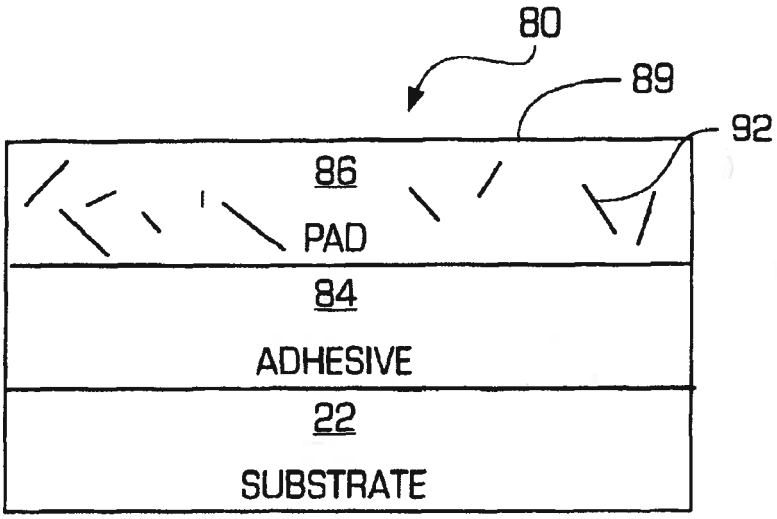
80
89
92
86
PAD
84
ADHESIVE
22
SUBSTRATE

FIG. 9

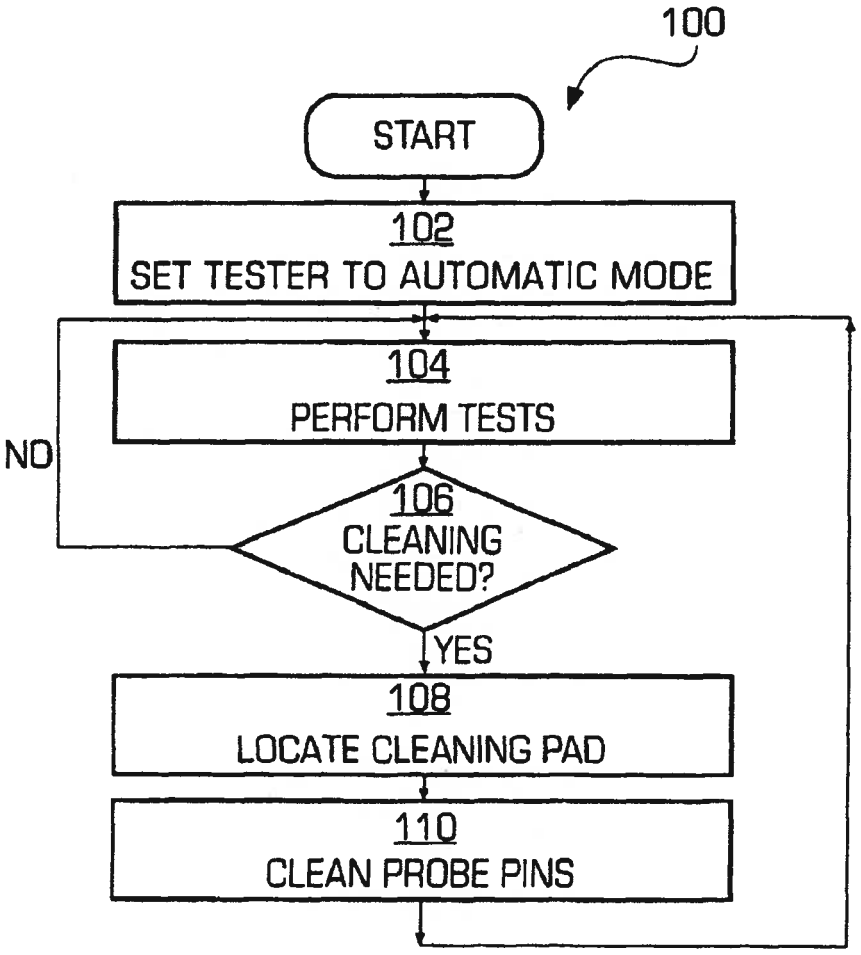
100
START
102
SET TESTER TO AUTOMATIC MODE
104
PERFORM TESTS
NO
106
CLEANING NEEDED?
YES
108
LOCATE CLEANING PAD
110
CLEAN PROBE PINS

FIG. 10

CLEANING SYSTEM, DEVICE AND METHOD

RELATED CASES/PRIORITY CLAIM

This application is a continuation in part and claims priority under 35 USC 120 to U.S. patent application Ser. No. 09/624,750, filed on Jul. 24, 2000 now U.S. Pat. No. 6,777,966 and entitled "Cleaning System, Device and Method" which in turn claims priority under 35 USC 119(e) to U.S. Provisional Patent Application No. 60/146,526 filed Jul. 30, 1999. Both applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates generally to a medium for cleaning a manual test interface while it is still in the prober. This manual interface is generally referred to as a probe card, which is used in the prober to make an electrical connection between the die on a silicon wafer and the tester so that the functionality of the die may be evaluated.

Currently, the method for cleaning the probe card is to remove it from the prober and manually clean the debris from the probe tips. The probe tips need to be cleaned to remove debris from them since the debris reduces the quality of the electrical circuit completed by the contact of the probe tips to any surfaces on a die. The completed electrical circuit is used to evaluate the electrical characteristics of the die by the test apparatus. The degradation of the quality of the electrical circuit caused by the probe tip debris may be interpreted by the test apparatus as a failure of the die under test even though the die is functioning correctly. This false failure of the die results in the rejection or the rework of good die thereby increasing the cost of the final products sold. In the industry, it has been seen that a 1% change in yield from an individual prober can equate to more than $1,000,000 per annum. Therefore, with thousands of probers operating worldwide, the impact to the industry from maintaining clean probes during testing can be very substantial.

Individual semiconductor (integrated circuit) devices are typically produced by creating multiple devices on a silicon wafer using well known semiconductor processing techniques including photolithography, deposition, and sputtering. Generally, these processes are intended to create multiple, fully functional integrated circuit devices prior to separating (singulating) the individual devices (dies) from the semiconductor wafer. However, in practice, physical defects in the wafer material and defects in the manufacturing processes invariably cause some of the individual devices to be non-functional, some of which may be repairable. It is desirable to identify the defective devices prior to separating or cutting the dies on the wafer. In particular, some product is actually repairable when the flaws are caught at the wafer lever. Other product may not be repairable but may be used in a downgraded application from the original product. This determination of the product's capabilities (a product definition provided by electrical probe testing) at the wafer level saves the manufacturer considerable cost later in the manufacturing process. In addition, product cost may be reduced if defective devices are identified.

To enable the manufacturer to achieve this testing capability a probe card, prober and tester are employed to make temporary electrical connections to the bonding pads, solder or gold bumps or any surface on the chip where connection can be made by making manual contact to that surface. The surface may be on the individual circuit device or on multiple circuit devices when the devices are still part of a wafer. Once the connections between the tester and the circuit device are made, power and electrical signals are transferred from the tester to the device for testing, to determine its functionality and whether the device is accepted or rejected for further processing. Typically, the temporary connections to the device bonding elements are made by contacting multiple electrically conductive probes (often needle like structures) against the electrically conductive bonding elements of the device. By exerting controlled pressure (downwards force on the bonding pads) of the probe tips against the bonding pads, solder balls and/or gold bumps, a satisfactory electrical connection is achieved allowing the power, ground and test signals to be transmitted.

The tester and prober need a manual interface to the bonding elements on the die to achieve contact. A probe card having a plurality of probes is used to make the connection with the bonding pads of the semiconductor die. The probes may be cantilever beams or needles or vertical beams. Typically, each probe is an inherently resilient spring device acting as a cantilever beam, or as an axially loaded column. A variation is to mount multiple probes in a spring-loaded support. In a conventional prober, the probe card, and its multiple probes, are held in precise mechanical alignment with the bonding elements of the device under test (or multiple devices, or wafer as the case may be) and the device is vertically translated into contact with the tips of the probes. In the typical prober, the tips of the probes may perform a scrubbing action in which the tip of the probes moves horizontally as it contacts the bonding pad in order to scrub away oxide, or any other material on the pad, that may inhibit the electrical contact between the probes and the bonding pads. Although the scrubbing action improves the electrical contact between the probe tip and the bonding pad, it unfortunately also generates some debris (the scraped up oxide or other debris) that may also prevent the probe tip from making a good electrical contact with the bonding pad. Alternatively, the probe tip may press vertically into the bonding pad, solder or gold bump with sufficient force to penetrate any surface material and establish good electrical contact. The probe tip may become contaminated with contaminates such as aluminum, copper, lead, tin, gold, bi-products, organic films or oxides resulting from the wafer and semiconductor device manufacturing and testing processes.

Typically, the debris generated by probing needs to be periodically removed from the probe elements to prevent a build-up which causes increased contact resistance, continuity failures and false test indications, which in turn results in artificially lower yields and subsequent increased product costs. Typically, the entire probe card with the plurality of probes must be removed from the prober and cleaned or abrasively cleaned in the prober. In a typical prober, the probe card can be cleaned several times an hour, several time during a single wafer test, several times during a wafer lot, several times before lot start, and several times after lot start. Also, some operators may clean the probe several times during the initial setup of the test equipment.

The process of cleaning in the prober using an abrasive pad burnishes the tips but it does not remove the debris. The burnishing actually causes wear to the probe card by shortening the probe tips. In addition, since it does not remove the debris, and since the debris exhibits a slight electrical charge, it attracts more debris so the probe card will require cleaning more often than the original clean card. Currently

the debris from burnishing can be removed manually by means of alcohol and a cotton tip swab, an air gun or an inert gas purge. The probers also utilize a brush unit comprised of natural or synthetic fibers to remove debris from the tips of a probe card. However, the brush operation tends to provide inconsistent cleaning and debris removal. The brush operation has the potential to damage the planarity and alignment of the probes and may push contaminants into the array of the probes or up into the probe guide-plates. Furthermore, some of the particulates during this operation may not be captured within the body of the brush and can become air-borne. This is of particular concern when these particulates are environmentally hazardous. Further details of this known brush unit are shown and described in U.S. Pat. No. 5,968,282. Each method cleans the probes but requires stopping the prober or manual intervention to perform the function.

Other contaminates, such as lead and tin, may be removed by abrasive cleaning/burnishing or cleaning the probes with a solution that may typically be an acid, for example. When probe cards which have collected lead and tin are burnished, particulates of lead are released into the air that cause environmental hazards. In addition, the acid solution requires a separate, rather expensive machine that sprays the solution onto the tips in a closed chamber. These typical cleaning processes are expensive since the tester will have down time and a replacement card must be purchased to run while the other probe card is being cleaned. In addition, the equipment and manual labor adds additional costs to the task performed.

It is desirable to provide a probe card cleaning device and method which overcomes the above limitations and drawbacks of the conventional cleaning devices and methods so that the probe cards may be cleaned more rapidly and effectively while in the prober and it is to this end that the present invention is directed. The cleaning device and method may also be used with other devices.

SUMMARY OF THE INVENTION

In accordance with the invention, a cleaning medium is provided that will clean the probes of a probe card without removing the probe card from the prober. In particular, the cleaning medium may be placed within the prober similar to a wafer being tested so that the probes of the probe card contact the cleaning medium periodically to remove debris and/or contaminates from the probes. In a preferred embodiment, the cleaning medium may include a substrate that may be shaped like a typical semiconductor wafer that typically fits into the prober. In other embodiments, the substrate may be of various shapes and sizes and thickness. In one embodiment, a ceramic plate or any type of substrate may be used that fits over or replaces the abrasive plate in the prober. The pad may have predetermined mechanical and/or chemical characteristics, such as abrasiveness, density, elasticity, tackiness, planarity, and/or chemical properties, such as being acetic or basic, so that when the probe tips contact the pad surface, the tips of the probes are cleaned and the debris and contaminates are removed from the tips. In another embodiment, the pad may be made of a material so that the probe tips may penetrate into or through the pad, which cleans the debris from the tips. In a preferred embodiment, the substrate may be a semiconductor wafer, ceramic, or any material to which the cleaning pad will attach. In another embodiment, the physical properties of the pad, such as density and abrasiveness, may be predetermined so as to clean the probe element and remove bonded or embedded debris from the probe elements without causing significant damage to the probe elements. In another embodiment, the physical properties of the pad, such as density and abrasiveness, may be predetermined so as to shape or reshape the probe elements during probing on or into the medium.

Thus, in accordance with the invention, a cleaning medium for cleaning probe elements in a semiconductor testing apparatus is provided wherein the cleaning medium comprises a substrate having a configuration to be introduced into the testing apparatus during normal testing operation, and a pad, secured to the substrate. The pad has predetermined characteristics, which clean debris from the probe elements and maintain or modify the shape of the probe element when the elements contact or penetrate into or through the pad.

In accordance with another aspect of the invention, a method for cleaning the probe elements on a prober or an analyzer is provided wherein the method comprises loading a cleaning medium into the prober, the cleaning medium having the same configuration as the wafers with the semiconductor dies normally tested by the testing apparatus and the cleaning medium having a top surface with predetermined properties, such as abrasiveness, tack, hardness, that clean the probes. The method further comprises contacting the probe elements with the cleaning medium during the normal testing operation in the prober so that any debris is removed from the probe elements during the normal operation of the prober or analyzer.

In accordance with another aspect of the invention, a method for maintaining or modifying the shape of the probe elements on a prober or an analyzer is provided wherein the method comprises loading a cleaning medium into the prober or analyzer, the medium having varying density, tack, abrasiveness or other physical characteristics which are optimized for various probe elements of the probe cards.

In accordance with another aspect of the invention, the pad may have a particular surface finish such that the prober/tester device is capable of detecting the surface of the cleaning pad. The surface texture may also contribute to the cleaning efficiency of the working surface polymer material. When the prober/tester is capable of detecting the surface of the cleaning pad, then the prober is able to be set into an automatic cleaning mode. In the automatic cleaning mode, the prober/tester will automatically determine when to clean its probe tips, locate the cleaning pad, clean the probe tips on the cleaning pad and then return to testing operations. In one embodiment of the invention, the pad surface may be a matte finish which permits the prober/tester to optically determine the location of the surface of the cleaning pad. In another embodiment of the invention, the pad may be formed from a conductive polymer such that a tester/prober that detects a surface using conductance is able to detect the surface of the cleaning pad.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of an automated testing system that may include the cleaning device in accordance with the invention;

FIG. **2** is a top view of the automated testing system of FIG. **1**;

FIG. **3** is a top view of an embodiment of a cleaning device in accordance with the invention;

FIG. **4** is a sectional view taken along line A—A in FIG. **3** of the cleaning device in accordance with the invention;

FIG. **5** is a flowchart illustrating a method for cleaning a probe tip in accordance with the invention;

FIGS. **6**A and **6**B are diagrams illustrating another embodiment of the cleaning device in accordance with the invention;

FIG. **7** is a flowchart illustrating a method for manufacturing the cleaning device shown in FIGS. **6**A and **6**B;

FIGS. **8**A–**8**C are diagrams illustrating a matte finish cleaning device in accordance with the invention;

FIG. **9** is a diagram illustrating a conductive cleaning device in accordance with the invention; and

FIG. **10** is a diagram illustrating an automatic prober/tester cleaning method in accordance with the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The invention is particularly applicable to a cleaning medium for cleaning the probes in a prober and it is in this context that the invention will be described. It will be appreciated, however, that the device and method in accordance with the invention has greater utility, such as cleaning other types of semiconductor processing equipment. The cleaning method can also be used on an analyzer which is a metrology tool used in the routine maintenance of probe cards.

FIGS. **1** and **2** are diagrams illustrating a testing system **10** that may be cleaned using the cleaning medium in accordance with the invention. In particular, the system **10** may include a tester **11** electrically connected to a prober machine **12** that may actually apply the probes to the semiconductor wafer or die and test them. The prober machine **12** may further include a prober **13** and an interface head **14** as shown in FIG. **1**. The prober machine **12** may also have an abrasion/sanding disk **16**, which is typically used to burnish the probe tips, as shown in FIG. **2**. The prober may also include a brush attachment that is shown in more detail in U.S. Pat. No. 5,968,282 which is incorporated herein by reference. The prober machine **12** may also include a prober chuck **15** that moves the wafers/dies during the testing process. Instead of the typically removing the prober card in order to clean the probe elements, the cleaning device in accordance with the invention permits the probe elements to be cleaned while the prober is operating. In particular, a cleaning wafer cassette containing the cleaning device in accordance with the invention may be introduced periodically into the testing system in accordance with the invention. Alternatively, a cleaning device in accordance with the invention may be loaded into each cassette with other wafers being tested so that the probe elements are cleaned each time a cassette of wafers is tested. Thus the cleaning medium will clean the probe needles during the normal testing operation of the prober. Now the cleaning medium in accordance with the invention will be described in more detail.

FIGS. **3** and **4** are diagrams illustrating an embodiment of a cleaning device **20** in accordance with the invention. In accordance with the invention, the cleaning device **20** may be manufactured using various substrate materials, different size substrates, different shape substrates or without a substrate in some applications. As shown in FIG. **4**, the cleaning device **20** may include a substrate **22** and a pad **24** secured or adhered to a surface **25** of the substrate. The substrate may be any material that can support the pad and has sufficient strength to resist breaking when the probes come into contact with the pad and generate a contact force. Thus, the substrate may be plastic, metal, glass, silicon, ceramic or any other similar material. In a preferred embodiment, the substrate **22** may be a semiconductor wafer. The wafer surface **25** onto which the pad is secured or adhered may have a flat mirror finish or a slightly abrasive roughness finish with microroughness of about 1–3 μm. The abrasive finish may burnish/abrade the probe tips during the cleaning process.

The pad **24** may be made of a material with predetermined properties that contribute to the cleaning of the probe elements tips that contact the pad. For example, the pad may have abrasive, density, elasticity, and/or tacky properties that contribute to cleaning the probe tips. The abrasiveness of the pad will loosen debris during the scrubbing action and remove unwanted material from the tips. Using a more dense material, the abrasiveness of the pad may round or sharpen the probe tips. The pad may further be used to reshape a flat probe tip into a semi-radius or a radius probe tip. Furthermore, the pad may be used to re-furbish the tip shape of "used" probe cards. Typical abrasives that may be incorporated into the pad may include aluminum oxide, silicon carbide, and diamond although the abrasive material may also be other well known abrasive materials. The abrasive may include spatially distributed particles of aluminum oxide, silicon carbide, or diamond. The tackiness of the pad may cause any debris on the probe tip to preferentially stick to the pad and therefore be removed from the probe tip. In a preferred embodiment, the pad may be made of an elastomeric material that may include rubbers and both synthetic and natural polymers. The elastomeric material may be a material manufactured with a slight tackiness or some abrasive added to the body of the material. The material may have a predetermined elasticity, density and surface tension parameters that allow the probe tips to penetrate the elastomeric material and remove the debris on the probe tips without damage to the probe tip, while retaining the integrity of the elastomeric matrix. In the preferred embodiment, the elastomeric material may be the Probe Clean material commercially sold by International Test Solutions, Inc. The material may have a thickness generally between 1 and 20 mils thick. The thickness of the pad may be varied according the specific configuration of the probe tip.

As the one or more probe elements of the prober contact the pad during the normal operation of the prober machine, they exert a vertical contact force to drive the probe element into the pad where the debris on the probe elements will be removed and retained by the pad material. In other embodiments of the cleaning system, the cleaning efficiency of the material can be improved with either a horizontal translation and/or an orbital motion of the cleaning unit during the probe tip cleaning operation.

The amount and size of the abrasive material added to the elastomer may vary according the configuration and material of the probe elements to achieve a pad that will remove the debris but will not damage the probe elements. The pad material and abrasiveness may be adjusted during the manufacturing of a pad when the pad is used to reshape, sharpen or refurbish the probe element tips. The same cleaning and reshaping may also be accomplished by the substrate alone.

Once the optimal probe tip shape has been established, conventional abrasive methods affect the integrity of the tip shape, probe card planarity and alignment, and, over time, degrade probe card performance and reduce probe card service life. Furthermore, these destructive cleaning methods remove material from the test probe tip and reduce the probe card life by damaging the test probe tip, degrading the electrical performance and compromising any test probe tip shape related properties. In accordance with the invention, the cleaning system and pad not only removes and collects adherent particulates from the test probe contact surface but maintains the shape and geometric properties of the test

probe tip contact surface. The insertion of the test probe tips into the cleaning device **20** removes adherent debris from the probe tip length and probe beam without leaving any organic residue that must be removed. Spectral analysis shows no material transfer from the cleaning material onto the contact surface of the test probe. Furthermore, the overall probe card electrical characteristics are unaffected. Now, a method for cleaning a plurality of probe elements in accordance with the invention will be described.

FIG. **5** is a flowchart illustrating a method **30** for cleaning a plurality of probes in accordance with the invention. The method accomplishes the goal of removing the debris from the probe tips without removing the probe card from the prober, which increases the productivity of the tester. In step **31**, the cleaning device, that may have the same size and shape as typical wafers containing the dies being tested by the tester, may be inserted into a wafer cleaning tray. In accordance with the invention, the cleaning medium may be located in the wafer cleaning tray or one or more cleaning pads may be inserted into one or more cassettes that also contain wafers with semiconductor devices to be tested so that, as each cassette is run through the tester, the cleaning device in the cassette cleans the probe elements. In step **32**, the tester is operated and tests the semiconductor dies on the wafers. In step **33**, the prober identifies a predetermined number of failures in the dies being tested which indicates that the prober element's may be dirty. In step **34**, the cleaning device in accordance with the invention (a wafer) is loaded and aligned with the chuck. In step **35**, the probe elements in the tester contact the cleaning device so that the debris is removed from the probe elements or the tips of the probes may be reshaped. As described above, this cleaning step may occur either when the cleaning device is periodically installed from the wafer cleaning tray into the prober or every time from the wafer cassette, or anytime the prober cleans the probe card on the burnishing plate. In step **36**, the cleaning is completed and the prober returns to testing the die and wafers. In step **37**, the cleaning wafer is returned to the cleaning tray so that the prober machine can continue to test dies. In accordance with the invention, the cleaning device does not interrupt, in any way, the operation of the prober since the cleaning of the probes is accomplished during the normal operation of the testing machine. In this manner, the cleaning device is inexpensive and permits the probe to be cleaned and/or shaped without removing the probe card from the prober. Now, another embodiment of the cleaning device in accordance with the invention will be described.

FIGS. **6**A and **6**B are diagram illustrating a second embodiment of a cleaning device **40** in accordance with the invention. In more detail, the cleaning device **40** may include one or more different layers of material which may clean or sharpen the probe elements as will now be described. Thus, in accordance with this embodiment of the invention, the cleaning pad may be placed on a substrate for use on the abrasive plate in the prober, the prober chuck, analyzer or any other machine. As shown in FIG. **6**A, the cleaning device **40** may include a frame **42** that encloses one or more layers of chemical cells **44**. The layers in the cleaning device may be made of a material which exhibits acetic or basic chemical properties which may be used to oxidize and/or reduce contaminates on the probe tips. The layers may also be made of materials that induce chemical reactions and/or mechanical actions that remove such contaminates. The removal of the contaminates, such as heavy metals, that may be environmentally hazardous will be trapped on or in the pad so that they will not be dispersed into the air. This embodiment will now be described in more detail with reference to FIG. **6**B.

FIG. **6**B is a diagram illustrating the second embodiment of a cleaning device **40** in accordance with the invention with a probe needle **52** inserted into the layers of the cleaning device in order to clean the probe needle. In more detail, the cleaning device may have a shape of a typical wafer so that it may be used in-line and may further include one or more different layers of material. In particular, the cleaning device **40** may include a substrate **54** having a wall wherein the wall may be constructed of several pieces made of chemically resistant material. The walls may include a bottom portion **56**, a middle portion **58** and an upper portion **60** stacked on top of each other with a layer of elastomeric material **61** in between the portions of the wall. The walls of the substrate form a well region into which one or more different layers of chemicals may be placed and these chemicals may etch away materials struck onto the probe needles. A first bottom well **64** of the substrate may be filled with an acid matrix such as acetic acid, as described with reference to FIG. **7** and sealed into the well by a layer **61** of elastomeric material. The chemical matrix may consist of chemicals in any form, solid, liquid, gas, or encapsulated, emulsified, saturated, gelled, or the like, provided the amount of chemical induces the desired reaction. Once the seal is in place, the middle portion of the wall **58** may be positioned and secured to the seal by an adhesive, mechanical, thermal, or like methods to form a second well **66**. In the second well **66**, a peroxide mixture that gels is placed into the well as described in more detail with reference to FIG. **7**, and sealed by a sealing layer **61**. Finally, the upper portion **60** is secured to the top seal layer to form the cleaning device in accordance with the invention.

During the cleaning operation, the probe needle **52** may penetrate through the two seal layers **61** and thus extend into the acid and peroxide matrix layers in the wells. The acid and peroxide may react with the contaminates on the probe needle to remove heavy metals and the like. In particular, the acid and peroxide matrix may remove the contaminates from the probe needle and the contaminants may be trapped in the cleaning device by the sealing layers **61**. Now, a method for manufacturing the cleaning device shown in FIGS. **6**A and **6**B will be described.

FIG. **7** is a flowchart illustrating a method **70** for manufacturing the cleaning device **40** shown in FIGS. **6**A and **6**B. In particular, in step **72**, a substrate with a well region is provided. The substrate is typically made of a chemical resistant material such as certain types of plastic. In step **74**, the lower cell of the substrate is filled with the appropriate chemicals and sealed using the elastomeric material. In step **76**, the upper cell of the substrate is filled with the appropriate chemicals and sealed using the elastomeric material. Thus, a two layer cleaning device in accordance with the invention is formed. In accordance with the invention, however, the cleaning device may have any number of different layers of chemicals wherein each different layer may serve a particular function such as removing a different contaminant from the probe element. The above embodiment is typically used for a system that tests the wafers or one or more dies on a semiconductor wafer prior to being encapsulated into a package. Now, another embodiment of the cleaning device will be described wherein the cleaning device may be used for cleaning the probe elements of a handler or a tester that may be used to electrically test the leads of a packaged integrated circuit.

In accordance with another embodiment of the invention, the cleaning device described above may also be used in

connection with an handling/testing apparatus that is used to handling and testing integrated circuits (IC) wherein an individual semiconductor die from the wafer described above has been encapsulated into a material, such as plastic. The IC package may have one or more electrical leads extending out from the package that communicate electrical signals, such as a power signal, a ground signal, etc., with the die inside of the package. The testing/handling apparatus may have a plurality of probe elements (similar to the probe card tester described above) that contact the leads of the package and test the electrical characteristics of the packaged IC in a typical manner. Similar to the probe card cleaner embodiment, the cleaning device may be, in a preferred embodiment, a semiconductor shaped substrate with a pad material wherein the probe elements of the handler/tester may contact the pad periodically to remove debris from the tips of the probe elements as described above. The various different materials used for the cleaning device including the multi-layer embodiment may be used with the tester/handler. The size of the cleaning device may be modified slightly to fit the size and shape of the particular tester/handler. In the multi-layer embodiment, a laminate-like structure may be used wherein the cleaning device has a pad/polymer layer on top of a substrate which is on top of another pad/polymer layer, or a first pad/polymer layer, a second pad/polymer layer underneath the first pad/polymer layer and a substrate underneath the second pad/polymer layer, etc. Thus, in accordance with the invention, the number of pad/polymer/substrate layers may be controlled to provide control of the overall thickness of the cleaning device as well as the compliance of the thickness of the cleaning device relative to the conditioning unit. This multi-layer embodiment would also provide "edge-side" cleaning for the interior of the socket and contactors of the prober. Now, another embodiment of the cleaning pad that permits a tester/prober to operate in an automatic cleaning mode will be described.

Most probers have an automatic cleaning mode in which the prober will automatically determine that its probe elements are dirty (using various mechanisms described below) and then perform a cleaning operation as needed. In accordance with the invention, the embodiments of the cleaning pad described below permit the prober to operate in the automatic cleaning mode. Thus, the cleaning pad embodiments described below permit the prober to automatically detect the surface of the cleaning pad (by various mechanisms described below) and therefore clean its probe elements automatically as described below in more detail. Now, two different embodiments of the cleaning device that permits the automatic cleaning of the probe elements will be described.

FIGS. **8**A–**8**C are diagrams illustrating a cleaning device **80** in accordance with the invention with a matte surface finish. As shown in FIG. **8**A, the cleaning device **80** initially has a first release liner layer **88** that is made of a known non-reactive polymeric film material and preferably made of a polyester (PET) film. The first release liner may have a matte finish or other "textured" features to improve the optical detection of the cleaning device and/or improve cleaning efficiency. A pad layer (working surface polymer) **86** is formed on the first release liner layer **88**. The pad layer **86** is then formed on top of the adhesive layer wherein the pad layer is made from an elastomeric material that may include rubbers and both synthetic and natural polymers. The elastomeric material may be manufactured with a slight tackiness or some abrasive particulates added to the body of the material. The material may have a predetermined elasticity, density, and surface tension parameters that allow the tips to penetrate the elastomeric material and remove the debris on the test probe without damage to the test probe tip, the test probe contact surface, or test probe shape, while retaining the integrity of the elastomeric matrix and without material transfer from the cleaning material onto the contact surface of the test probe. Preferably, the pad material may be Probe Clean material that is commercially available from and manufactured by International Test Solutions, Inc.

Next, an adhesive layer **84** is formed on the pad layer **86**. The adhesive layer is a compound and adheres a pad layer **86** to a substrate **22** (See FIG. **8**B) when the cleaning device is applied to a substrate. In one form, the adhesive layer is comprised of a resin or cross-linked compound and can have a tack value of 1 to 300 gram-force. In another form, adhesive layer is comprised of a resin or cross-linked compound that is considered to be permanent, that is, the cleaning material will be damaged before the adhesive layer is compromised. Finally, a second release liner layer **82** (made of the same material as the first release liner layer) is formed on the adhesive layer **84** wherein the-second release liner layer (also known as the back release liner layer) may be subsequently removed to expose the adhesive layer **84**. The first release liner layer **88** protects a working surface **89** of the pad layer **86** from debris/contaminants until the cleaning device **80** is ready to be used for cleaning a prober in a clean room. The cleaning device **80** as shown in FIG. **8**A may be in the form that is shipped to an entity that uses a prober/tester.

Then, as shown in FIG. **8**B, the second release liner layer **82** may be removed which exposes the adhesive layer **84**. The adhesive layer **84** may then be placed against the substrate **22** to adhere the cleaning device **80** to the substrate. In accordance with the invention, the substrate may be a variety of different materials as described above which have different purposes. For example, the substrate may be a wafer, but it may also be applied to the top of the sanding/abrasion disk (such as that shown in FIG. **1**) or other surfaces. As shown in FIG. **8**B, the working surface **89** of the cleaning device **80** is still protected from contaminants and debris by the first release liner layer **88**. When the user is ready to begin cleaning probe elements with the cleaning device **80** (and the cleaning device **80** is within the clean room with the prober/tester), the user removes the first release liner layer **88** as shown in FIG. **8**C which exposes the cleaning pad layer **86** so that the prober may be cleaned. In accordance with the invention, the removal of the first release liner layer **88** leaves the working surface **89** of the cleaning pad layer with a matte finish. In the preferred embodiment, the surface finish, smoothness, texture, and/or surface morphology of the cleaning pad can be obtained, developed, or, imparted to reflect the smoothness, texture, and/or surface morphology of the release liner.

Furthermore, the surface finish of the cleaning polymer, as well as, the surface finish of the release liner can be modified by solvent-induced effects.

In accordance with the invention, a prober/tester that detects the position of a surface, such as a cleaning device, using light or optical energy to detect the working surface **89** of the cleaning device **80** due to the matte surface so that the cleaning device **80** shown in FIG. **8**A-**8**C permits that prober to be run in an automatic cleaning mode as described in more detail below. For example, the prober may direct optical energy, such as visible light or infrared light or UV light, towards the working surface of the cleaning device and then receive the reflected light from the working surface of the cleaning device. From the received reflected optical

energy, the prober is able to accurately determine the location of the working surface of the cleaning device as is well known. In contrast, a typical substrate, such as a wafer, with a mirror finish does not permit the tester/prober to determine the working surface of the substrate due to the reflectivity of the substrate. Now, another embodiment of the cleaning device **80** that permits a prober/tester to operate in an automatic cleaning mode will be described.

FIG. **9** is a diagram illustrating a cleaning device **80** in accordance with the invention which is conductive. FIG. **9** illustrates a completed cleaning device **80** wherein the cleaning device **80** is adhered to a substrate **22** and the cleaning device **80** further comprises an adhesive layer **84** and a conductive cleaning pad layer **90**. As above, the adhesive layer **84** adheres the cleaning pad layer **90** to the substrate **22**. In this embodiment of the invention, the cleaning pad layer **90** is conductive so that a prober/tester that determines the location of a surface using conductance testing is able to accurately locate the working surface **89** of the cleaning pad layer **90**. Thus, a prober/tester that performs a conductance test to detect a surface is able to operate in the automatic cleaning mode using the cleaning device **80** shown in FIG. **9**. In accordance with the invention, the cleaning pad layer **90** may be made conductive using a variety of different methodologies. For example, the material of the cleaning pad layer **90** may include an additive which makes the cleaning pad layer **90** conductive. The conductive additive or filler may be, for example, conductive carbon-graphite particles or fibers, metal plated abrasive particulates or fibers, metallic particulates or fibers, which make the cleaning pad layer conductive. In the alternative, a well known conductive polymer material, such as polyanilenes, polypyrroles, polythiophenes, or other well known conductive polymer materials, may be used for the cleaning pad layer **90**. A conductive element **92** is shown in FIG. **9** and may be implemented in various well known manners. The cleaning devices **80** shown are examples of the different embodiments of the invention which is a cleaning device that permits a prober/tester to detect the working surface of the cleaning device so that the tester/prober device is able to operate in an automatic cleaning mode. It is desirable to operate the prober/tester in the automatic cleaning mode which reduces the involvement of humans (and reduces the errors and contaminants) and also increases the throughput of the prober/tester. Now, an automatic prober/tester cleaning method in accordance with the invention will be described in more detail.

FIG. **10** is a diagram illustrating an automatic prober/tester cleaning method **100** in accordance with the invention. In a preferred embodiment, the method is implemented by software code/firmware (a sequence of computer instructions) residing in the prober device or in the tester device that is executed by a well known processor of the tester/prober device. The method may also be implemented using code that is hard-coded into a hardware device such as a microcontroller or other device. In step **102**, the tester/prober is set into the automatic cleaning mode. In step **104**, the prober performs its testing operations. In step **106**, the prober/tester determines if a cleaning is needed. The prober/tester may determine the desirability of cleaning using a variety of methods. For example, the prober/tester may monitor the parameters being determined by the tester and then choose to start a cleaning step when the parameters vary by some predetermined amount from the normal value. In the alternative, the prober/tester might clean at a fixed period rate (a predetermined number of testing operations before a clean operation.) Obviously, the prober/tester may determine the desirability of a cleaning step/process in various ways known to those of ordinary skill in the art. If a cleaning is not needed, then the prober/tester loops back to step **104** and continues testing. If a cleaning is needed, then, in step **108**, the prober/tester locates the position of the working surface of the cleaning device in accordance with the invention (using various methods including those described above of optical detection or conductance detection.) Then, in step **110**, the cleaning step is performed and the method loops back to step **104** to continue testing. Preferably, the cleaning device in accordance with the invention is located adjacent the tester/prober, such as on the sanding disk **16** shown in FIG. **1** so that a wafer with the cleaning device does not need to be moved into position. Thus, using the cleaning method described above, the throughput of the prober/tester is increased since the prober/tester may rapidly clean its probe elements and then resume testing with minimal delay.

In other embodiments of the cleaning system, a permanent adhesive may be used to affix the cleaning polymers onto the polyester substrate. The permanent adhesive prevents the polymer materials from sliding and maintains the integrity of the various material layers during the cleaning operation. The use of this permanent adhesive material better facilitates translational motion during the probe card cleaning operations.

The cleaning materials are currently applied onto a polyester film or directly onto a silicon wafer. The materials can also be directly applied to metallic substrates, such as aluminum and stainless, as well as onto ceramic substrates or practically any shape and size. In fact, the cleaning materials can be applied to practically any sort of substrate, within reason. The materials have applicability without a substrate and can be used for non-probe card related contactor cleaning applications.

For the Probe Scrub material, different substrates may be used for the abrasive lapping film. The abrasives in the standard lapping film are applied to a polyester backing and then the cleaning polymer is applied across the surface of the lapping film. In addition, "non-standard" substrates for the lapping film (polyester and low temperature epoxy binders for the abrasive particles seem to be the industry standard for abrasive, lapping materials) may be used. For these applications, a lapping film constructed from either a fabric substrate and a metallic foil substrate (or some combination) onto which the cleaning polymer will be applied may be used. Furthermore, a high temperature binder for the abrasive particles of the lapping film may be used. This combination of temperature resistant material layers will facilitate the use of Probe Scrub across a much wider temperature range.

While the foregoing has been with reference to a particular embodiment of the invention, it will be appreciated by those skilled in the art that changes in this embodiment may be made without departing from the principles and spirit of the invention, the scope of which is defined by the appended claims.

The invention claimed is:

1. A method for fabricating a cleaning device whose working surface is capable of being detected by a prober device, the method comprising:

forming a cleaning device having a working surface by forming a first release liner layer, forming a cleaning pad layer having a working surface on the first release liner layer, forming an adhesive layer on the cleaning pad layer, and forming a second release liner layer on

the adhesive layer wherein the first release liner layer is removed to create the matte finish of the working surface; and

removing a layer from the working surface wherein the removal of the layer imparts a matte finish to the working surface of the cleaning device.

2. A method for testing semiconductor devices in an automatic cleaning mode, the method comprising:

performing testing of semiconductor devices;

during the testing operation, automatically determining that a cleaning is to be performed;

automatically determining the location of a working surface of a cleaning device based on a characteristic of the working surface by directing optical energy towards the working surface of the cleaning device and determining the location of the working surface of the cleaning device based on the optical energy reflected off of the working surface of the cleaning device;

performing the cleaning using the cleaning device; and

continuing the testing of semiconductor devices.

3. The method of claim 2, wherein determining the working surface of the cleaning device further comprises measuring the conductance of the working surface of the cleaning device in order to determine the position of the working surface of the cleaning device.

4. The method of claim 2, wherein performing the cleaning further comprises moving a probe element in a horizontal motion.

5. The method of claim 2, wherein performing the cleaning further comprises moving a probe element in an orbital motion.

6. A method for testing packaged semiconductor devices, the method comprising:

performing testing of the packaged semiconductor devices;

during the testing operation, automatically determining that a cleaning is to be performed;

automatically determining the location of a working surface of a cleaning device based on a characteristic of the working surface by directing optical energy towards the working surface of the cleaning device and determining the location of the working surface of the cleaning device based on the optical energy reflected off of the working surface of the cleaning device;

performing the cleaning using the cleaning device; and

continuing testing of packaged semiconductor devices.

7. The method of claim 6, wherein determining that cleaning is to be performed further comprises measuring the parameters of each semiconductor device being tested and initiating a cleaning step when the measured parameters vary from a normal value.

8. The method of claim 6, wherein determining that cleaning is to be performed further comprises performing a cleaning step after a predetermined number of testing operations.

9. The method of claim 8, wherein determining the working surface of the cleaning device further comprises measuring the conductance of the working surface of the cleaning device in order to determine the position of the working surface of the cleaning device.

10. The method of claim 8, wherein performing the cleaning further comprises moving a probe element in a horizontal motion.

11. The method of claim 8, wherein performing the cleaning further comprises moving a probe element in an orbital motion.

* * * * *

EXHIBIT F

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(54) **WORKING SURFACE CLEANING SYSTEM AND METHOD**

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Publication Classification

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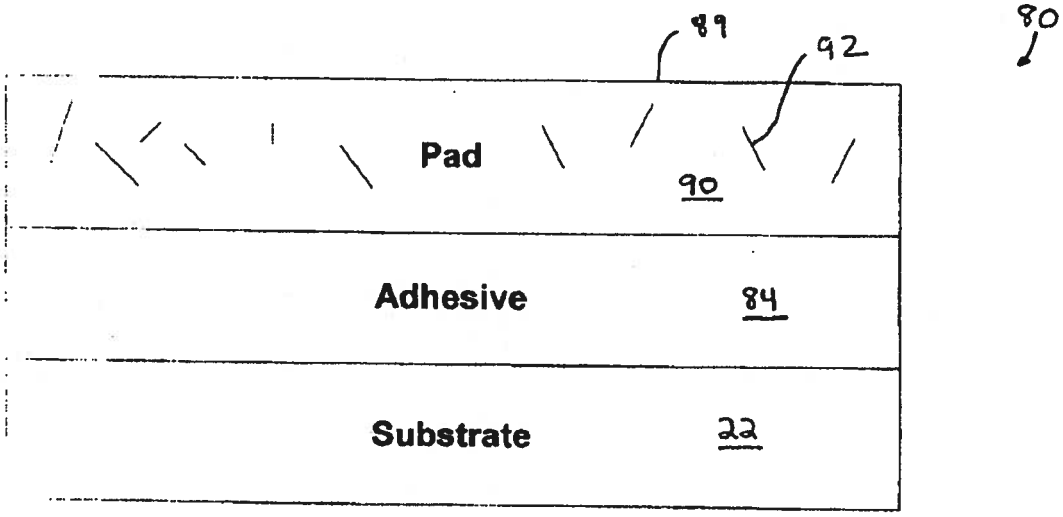
B08B 3/12 (2006.01)

(52) **U.S. Cl.** **134/6**; 134/1

(57) **ABSTRACT**

A cleaning device cleaning method is provided wherein the surface of the cleaning device is cleaned of accumulated debris and particulates.



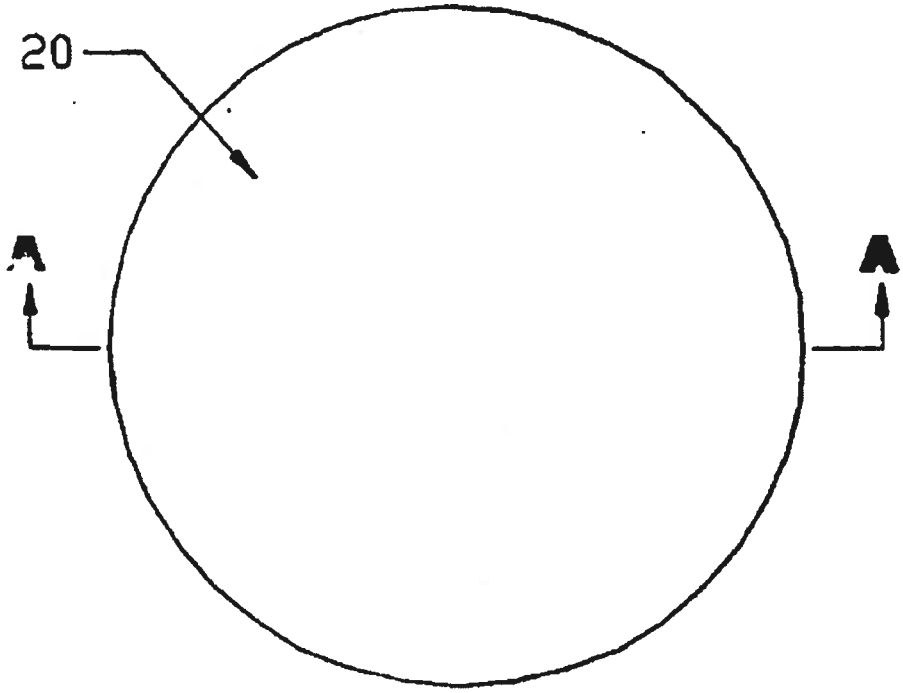


FIGURE 1

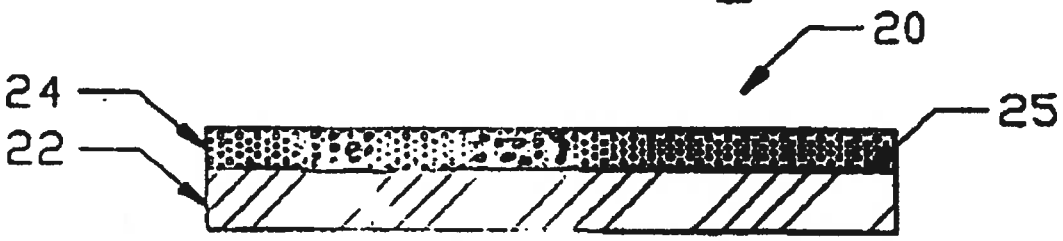


FIGURE 2

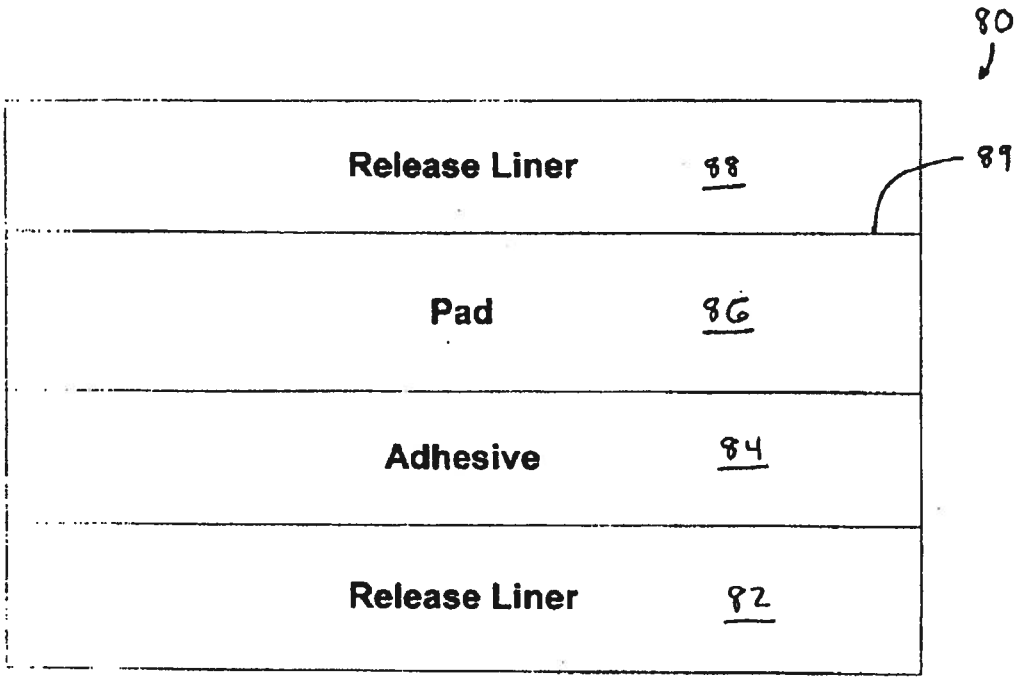


FIGURE 3A

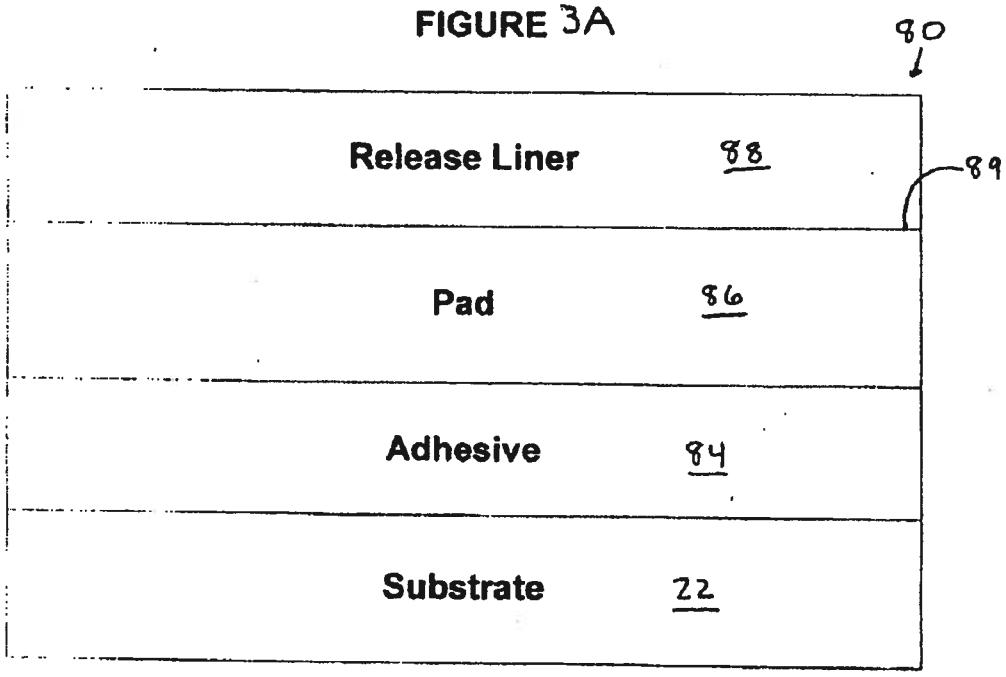


FIGURE 3B

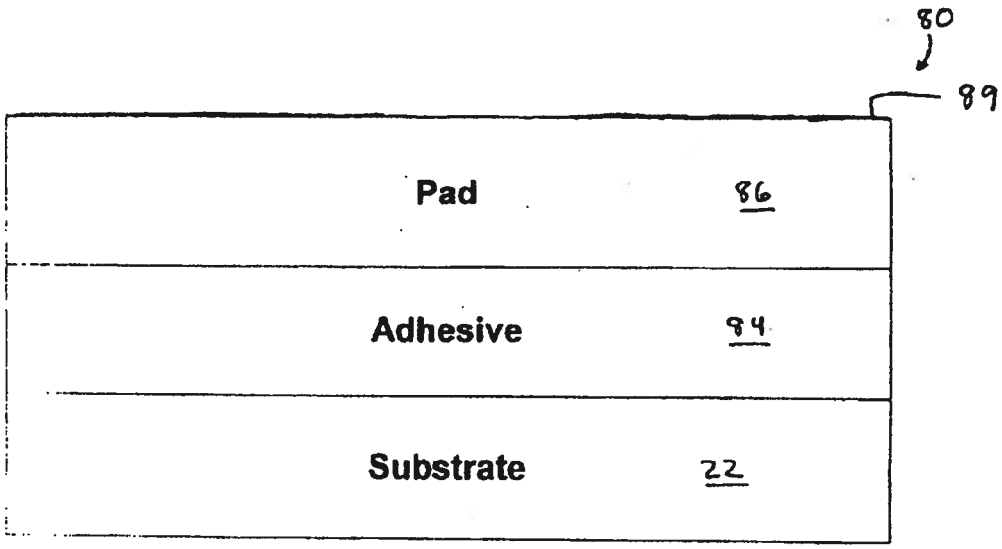


FIGURE 3C

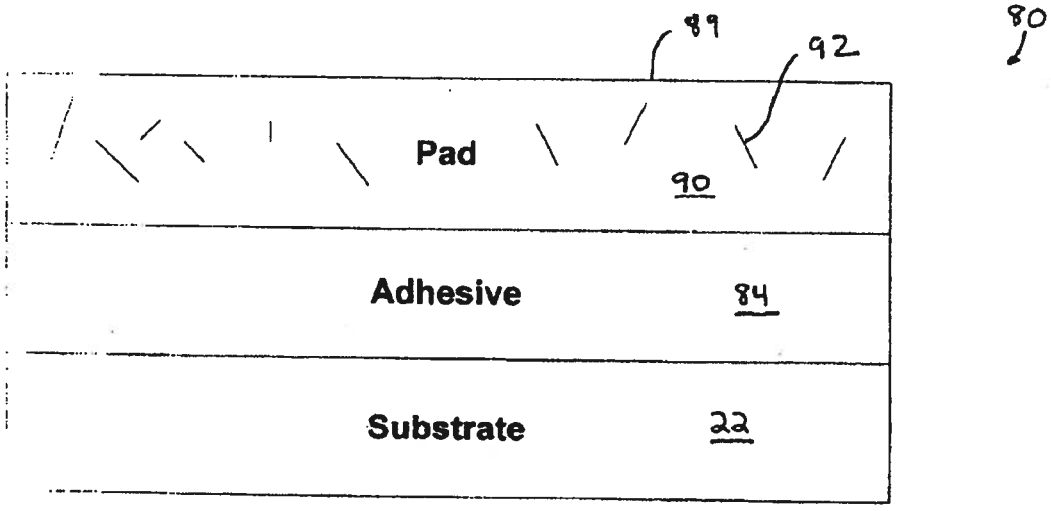


FIGURE 4

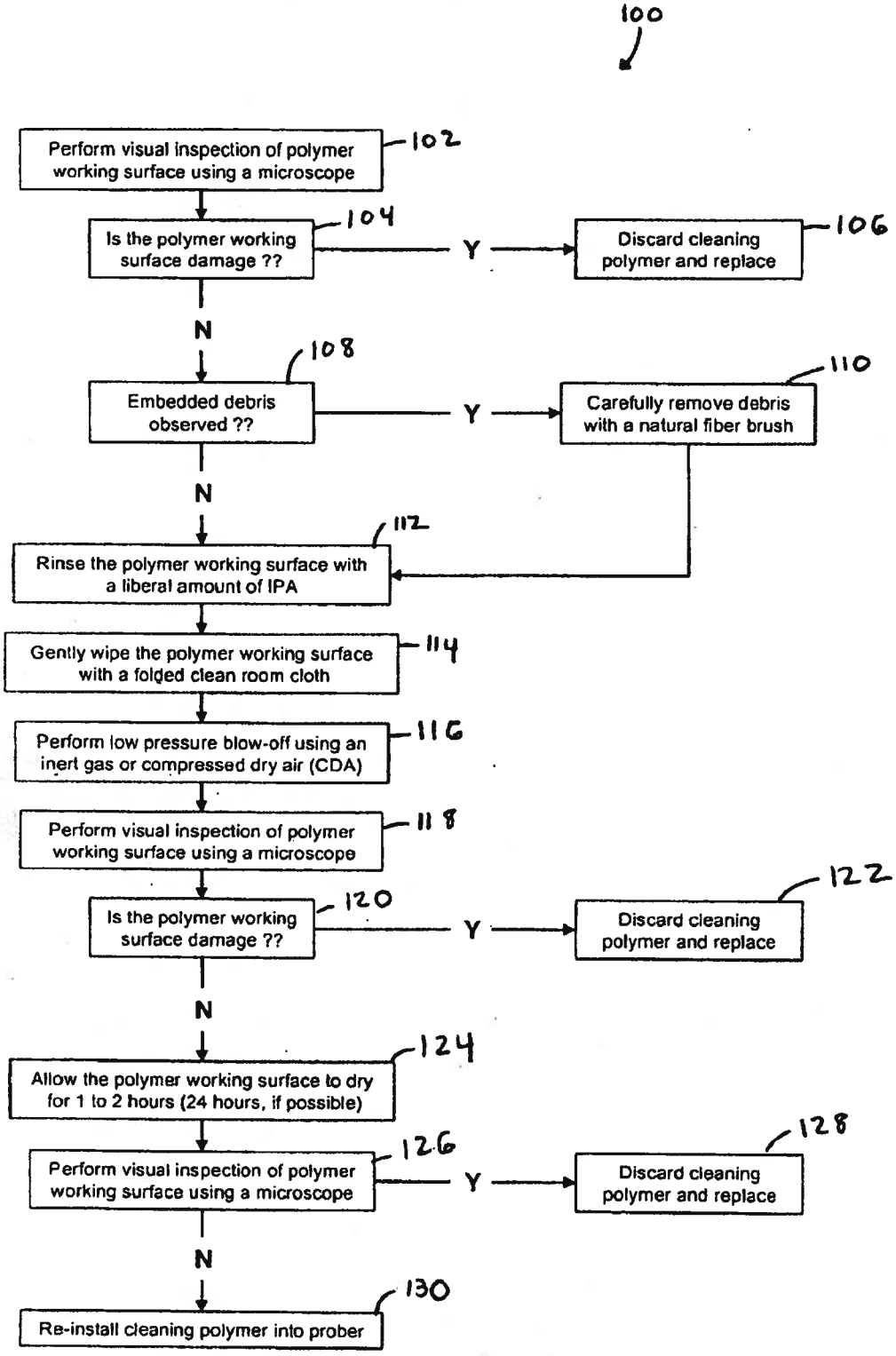

100
Perform visual inspection of polymer working surface using a microscope
102
Is the polymer working surface damage ??
104
Y
Discard cleaning polymer and replace
106
N
Embedded debris observed ??
108
Y
Carefully remove debris with a natural fiber brush
110
N
Rinse the polymer working surface with a liberal amount of IPA
112
Gently wipe the polymer working surface with a folded clean room cloth
114
Perform low pressure blow-off using an inert gas or compressed dry air (CDA)
116
Perform visual inspection of polymer working surface using a microscope
118
Is the polymer working surface damage ??
120
Y
Discard cleaning polymer and replace
122
N
Allow the polymer working surface to dry for 1 to 2 hours (24 hours, if possible)
124
Perform visual inspection of polymer working surface using a microscope
126
Y
Discard cleaning polymer and replace
128
N
Re-install cleaning polymer into prober
130

FIGURE 5

WORKING SURFACE CLEANING SYSTEM AND METHOD

PRIORITY CLAIM

[0001] This application claims priority under 35 USC 119(e) to U.S. Provisional Application Ser. No. 60/614,073 filed on Sep. 28, 2004 and entitled "Working Surface Cleaning System and Method" which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The invention relates generally to a method for cleaning a working surface of a cleaning device and in particular to an apparatus and method for cleaning a surface of a semiconductor tester/prober cleaning device.

BACKGROUND OF THE INVENTION

[0003] Individual semiconductor (integrated circuit) devices are typically produced by fabricating multiple devices on a wafer using well known semiconductor processing techniques including photolithography, deposition, and sputtering. Generally, these processes are intended to create multiple, fully functional integrated circuit devices prior to separating (singulating) the individual devices (dies) from the semiconductor wafer. However, in practice, physical defects in the wafer material and/or defects in the manufacturing processes invariably cause some of the individual devices to be non-functional, some of which may be repairable. It is desirable to identify the defective devices prior to separating or cutting the dies from the wafer. In particular, some product is actually repairable when the flaws are caught at the wafer lever. Other product may not be repairable but may be used in a downgraded application from the original product. This determination of the product's capabilities (a product definition provided by electrical probe testing) at the wafer level saves the manufacturer considerable cost later in the manufacturing process. In addition, product cost may be reduced if defective devices are identified.

[0004] To enable the manufacturer to achieve this testing capability, a probe card, prober and tester are employed to make temporary electrical connections to the bonding pads, solder or gold bumps or any surface on the chip where connection can be made by making manual contact to that surface. The surface may be on the individual circuit device or on multiple circuit devices when the devices are still part of a wafer. Once the connections between the tester and the circuit device are made, power and electrical signals are transferred from the tester to the device for testing to determine its functionality and whether the device is accepted or rejected for further processing. Typically, the temporary connections to the device bonding elements are made by contacting multiple electrically conductive probes (often needle like structures) against the electrically conductive bonding elements of the device. By exerting controlled pressure (downwards force on the bonding pads) of the probe tips against the bonding pads, solder balls and/or gold bumps, a satisfactory electrical connection is achieved allowing the power, ground and test signals to be transmitted.

[0005] The tester and prober need a manual interface to the bonding elements on the die to achieve contact. A probe card having a plurality of probes is used to make the connection with the bonding pads of the semiconductor die. The probes may be cantilever beams or needles or vertical beams. Typically, each probe is an inherently resilient spring device acting as a cantilever beam, or as an axially loaded column. A variation is to mount multiple probes in a spring-loaded support. In a conventional prober, the probe card, and its multiple probes, are held in precise mechanical alignment with the bonding elements of the device under test (or multiple devices, or wafer as the case may be) and the device is vertically translated into contact with the tips of the probes. In the typical prober, the tips of the probes may perform a scrubbing action in which the tip of the probes moves horizontally as it contacts the bonding pad in order to scrub away oxide, or any other material on the pad, that may inhibit the electrical contact between the probes and the bonding pads. Although the scrubbing action improves the electrical contact between the probe tip and the bonding pad, it unfortunately also generates some debris (the scraped up oxide or other debris) that may also prevent the probe tip from making a good electrical contact with the bonding pad. Alternatively, the probe tip may press vertically into the bonding pad, solder or gold bump with sufficient force to penetrate any surface material and establish good electrical contact. The probe tip may become contaminated with contaminates such as aluminum, copper, lead, tin, gold, bi-products, organic films or oxides resulting from the wafer and semiconductor device manufacturing and testing processes.

[0006] Typically, the debris generated by probing needs to be periodically removed from the probe elements to prevent a build-up which causes increased contact resistance, continuity failures and false test indications, which in turn results in artificially lower yields and subsequent increased product costs. In the industry, it has been seen that a 1% change in yield from an individual prober can equate to more than $1,000,000 per annum. Therefore, with thousands of probers operating worldwide, the impact to the industry from maintaining clean probes during testing can be very substantial. Typically, the entire probe card with the plurality of probes must be removed from the prober and cleaned or abrasively cleaned in the prober. In a typical prober, the probe card can be cleaned several times an hour, several time during a single wafer test, several times during a wafer lot, several times before lot start, and several times after lot start. Also, some operators may clean the probe several times during the initial setup of the test equipment.

[0007] To clean the prober and the probe elements, a cleaning device may be used that has a working surface attached to a wafer such as disclosed in U.S. Pat. No. 6,777,966. The cleaning device substantially cleans the probe elements while reducing debris and the like, but the polymer surface of the cleaning device eventually accumulates a substantial amount of probing debris as well as air-borne particulates. Thus, it is desirable to provide an apparatus and method for cleaning the surface of a cleaning device and it is to this end that the present invention is directed.

SUMMARY OF THE INVENTION

[0008] A method and apparatus for cleaning the surface of a cleaning device is described. The cleaning device is designed to remove loose debris and adherent materials

which are generated during a probing operation in a semiconductor manufacturing process. After repeated use, the polymer surface of the cleaning device accumulates a substantial amount of debris as well as various air-borne particulates, such as dust, skin, etc., found within a prober. The cleaning method provides a method for cleaning the surface of cleaning device so that the debris and particulate is removed from the cleaning device so that the cleaning device may be used again once it is cleaned.

[0009] In accordance with the invention, a method for cleaning the surface of a cleaning device is provided. In this method, a working surface of the cleaning device is visually inspected to detect debris associated with the working surface and the working surface is brushed with a brush when embedded debris is observed within the working surface. The working surface is then rinsed to remove other debris from the working surface and the working surface is dried following the rinsing.

[0010] In accordance with the invention, an apparatus for cleaning a cleaning device that has a working surface on top of a substrate is provided. The apparatus comprises a microscope for inspecting the working surface of the cleaning device to detect debris associated with the working surface. The apparatus further comprises a brush for brushing the working surface when debris embedded in the working surface is observed during the inspection of the working surface and a rinse device that is used to rinse the working surface to remove debris from the working surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is a top view of an example of a cleaning device having a working surface that may be cleaned in accordance with the invention;

[0012] **FIG. 2** is a sectional view of the cleaning device shown in **FIG. 1** taken along line A-A;

[0013] **FIGS. 3A-3C** are diagrams illustrating a matte finish cleaning device that may be cleaned in accordance with the invention;

[0014] **FIG. 4** is a diagram illustrating a conductive cleaning device that may be cleaned in accordance with the invention; and

[0015] **FIG. 5** is a flowchart illustrating a method for cleaning the surface of a cleaning device in accordance with the invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] The invention is particularly applicable to a working surface cleaning method that may be used with the prober element cleaning device described below and it is in this context that the invention will be described. It will be appreciated, however, that the method in accordance with the invention has greater utility since the method may be used to clean various different polymer surfaces.

[0017] **FIGS. 1 and 2** are diagrams illustrating an example of a cleaning device **20** that may be cleaned in accordance with the invention. The cleaning device **20** may be manufactured using various substrate materials, different size substrates, different shape substrates or without a substrate in some applications. As shown in **FIG. 2**, the cleaning device **20** may include a substrate **22** and a pad **24** secured or adhered to a surface **25** of the substrate. The substrate may be any material that can support the pad and has sufficient strength to resist breaking when the probes come into contact with the pad and generate a contact force. Thus, the substrate may be plastic, metal, glass, silicon, ceramic or any other similar material. In a preferred embodiment, the substrate **22** may be a semiconductor wafer. The wafer surface **25** onto which the pad is secured or adhered may have a flat mirror finish or a slightly abrasive roughness finish with microroughness of about 1-3 μm. The abrasive finish may burnish/abrade the probe tips during the cleaning process.

[0018] The pad **24** may be made of a material with predetermined properties that contribute to the cleaning of the probe elements tips that contact the pad. For example, the pad may have abrasive, density, elasticity, and/or tacky properties that contribute to cleaning the probe tips. The abrasiveness of the pad will loosen debris during the scrubbing action and remove unwanted material from the tips. Using a more dense material, the abrasiveness of the pad may round or sharpen the probe tips. The pad may further be used to reshape a flat probe tip into a semi-radius or a radius probe tip. Furthermore, the pad may be used to re-furbish the tip shape of "used" probe cards. Typical abrasives that may be incorporated into the pad may include aluminum oxide, silicon carbide, and diamond although the abrasive material may also be other well known abrasive materials. The abrasive may include spatially distributed particles of aluminum oxide, silicon carbide, or diamond. The tackiness of the pad may cause any debris on the probe tip to preferentially stick to the pad and therefore be removed from the probe tip. In a preferred embodiment, the pad may be made of an elastomeric material that may include rubbers and both synthetic and natural polymers. The elastomeric material may be a material manufactured with a slight tackiness or some abrasive added to the body of the material. The material may have a predetermined elasticity, density and surface tension parameters that allow the probe tips to penetrate the elastomeric material and remove the debris on the probe tips without damage to the probe tip, while retaining the integrity of the elastomeric matrix. In one example, the elastomeric material may be the Probe Clean material commercially sold by International Test Solutions, Inc. The material may have a thickness generally between 1 and 20 mils thick. The thickness of the pad may be varied according the specific configuration of the probe tip.

[0019] As the one or more probe elements of the prober contact the pad during the normal operation of the prober machine, they exert a vertical contact force to drive the probe element into the pad where the debris on the probe elements will be removed and retained by the pad material. In other embodiments of the cleaning system, the cleaning efficiency of the material can be improved with either a horizontal translation and/or an orbital motion of the cleaning unit during the probe tip cleaning operation.

[0020] The amount and size of the abrasive material added to the elastomer may vary according the configuration and material of the probe elements to achieve a pad that will remove the debris but will not damage the probe elements. The pad material and abrasiveness may be adjusted during the manufacturing of a pad when the pad is used to reshape,

sharpen or refurbish the probe element tips. The same cleaning and reshaping may also be accomplished by the substrate alone.

[0021] Once the optimal probe tip shape has been established, conventional abrasive methods affect the integrity of the tip shape, probe card planarity and alignment, and, over time, degrade probe card performance and reduce probe card service life. Furthermore, these destructive cleaning methods remove material from the test probe tip and reduce the probe card life by damaging the test probe tip, degrading the electrical performance and compromising any test probe tip shape related properties. In accordance with the invention, the cleaning system and pad not only removes and collects adherent particulates from the test probe contact surface but maintains the shape and geometric properties of the test probe tip contact surface. The insertion of the test probe tips into the cleaning device **20** removes adherent debris from the probe tip length and probe beam without leaving any organic residue that must be removed. Spectral analysis shows no material transfer from the cleaning material onto the contact surface of the test probe. Furthermore, the overall probe card electrical characteristics are unaffected. Now, several other examples of cleaning devices that may be cleaned in accordance with the invention are described.

[0022] **FIGS. 3A-3C** are diagrams illustrating an example of a cleaning device **80** with a matte surface finish. As shown in **FIG. 3A**, the cleaning device **80** initially has a first release liner layer **88** that is made of a known non-reactive polymeric film material and preferably made of a polyester (PET) film. The first release liner may have a matte finish or other "textured" features to improve the optical detection of the cleaning device and/or improve cleaning efficiency. A pad layer (working surface polymer) **86** is formed on the first release liner layer **88**. The pad layer **86** is then formed on top of the adhesive layer wherein the pad layer is made from an elastomeric material that may include rubbers and both synthetic and natural polymers. The elastomeric material may be manufactured with a slight tackiness or some abrasive particulates added to the body of the material. The material may have a predetermined elasticity, density, and surface tension parameters that allow the tips to penetrate the elastomeric material and remove the debris on the test probe without damage to the test probe tip, the test probe contact surface, or test probe shape, while retaining the integrity of the elastomeric matrix and without material transfer from the cleaning material onto the contact surface of the test probe. Preferably, the pad material may be Probe Clean material that is commercially available from and manufactured by International Test Solutions, Inc.

[0023] Next, an adhesive layer **84** is formed on the pad layer **86**. The adhesive layer is a compound and adheres a pad layer **86** to a substrate **22** (See **FIG. 3B**) when the cleaning device is applied to a substrate. In one form, the adhesive layer is comprised of a resin or cross-linked compound and can have a tack value of 1 to 300 gram-force. In another form, adhesive layer is comprised of a resin or cross-linked compound that is considered to be permanent, that is, the cleaning material will be damaged before the adhesive layer is compromised. Finally, a second release liner layer **82** (made of the same material as the first release liner layer) is formed on the adhesive layer **84** wherein the second release liner layer (also known as the back release liner layer) may be subsequently removed to expose the adhesive layer **84**. The first release liner layer **88** protects a working surface **89** of the pad layer **86** from debris/contaminants until the cleaning device **80** is ready to be used for cleaning a prober in a clean room. The cleaning device **80** as shown in **FIG. 3A** may be in the form that is shipped to an entity that uses a prober/tester.

[0024] Then, as shown in **FIG. 3B**, the second release liner layer **82** may be removed which exposes the adhesive layer **84**. The adhesive layer **84** may then be placed against the substrate **22** to adhere the cleaning device **80** to the substrate. In accordance with the invention, the substrate may be a variety of different materials as described above which have different purposes. For example, the substrate may be a wafer, but it may also be applied to the top of the sanding/abrasion disk (such as that shown in **FIG. 1**) or other surfaces. As shown in **FIG. 3B**, the working surface **89** of the cleaning device **80** is still protected from contaminants and debris by the first release liner layer **88**. When the user is ready to begin cleaning probe elements with the cleaning device **80** (and the cleaning device **80** is within the clean room with the prober/tester), the user removes the first release liner layer **88** as shown in **FIG. 3C** which exposes the cleaning pad layer **86** so that the prober may be cleaned. In accordance with the invention, the removal of the first release liner layer **88** leaves the working surface **89** of the cleaning pad layer with a matte finish. In the preferred embodiment, the surface finish, smoothness, texture, and/or surface morphology of the cleaning pad can be obtained, developed, or, imparted to reflect the smoothness, texture, and/or surface morphology of the release liner. Furthermore, the surface finish of the cleaning polymer, as well as, the surface finish of the release liner can be modified by solvent-induced effects.

[0025] **FIG. 4** is a diagram illustrating an example of a cleaning device **80** which is conductive. **FIG. 4** illustrates a completed cleaning device **80** wherein the cleaning device **80** is adhered to a substrate **22** and the cleaning device **80** further comprises an adhesive layer **84** and a conductive cleaning pad layer **90**. As above, the adhesive layer **84** adheres the cleaning pad layer **90** to the substrate **22**. In this embodiment of the invention, the cleaning pad layer **90** is conductive so that a prober/tester that determines the location of a surface using conductance testing is able to accurately locate the working surface **89** of the cleaning pad layer **90**. Thus, a prober/tester that performs a conductance test to detect a surface is able to operate in the automatic cleaning mode using the cleaning device **80** shown in **FIG. 4**. In accordance with the invention, the cleaning pad layer **90** may be made conductive using a variety of different methodologies. For example, the material of the cleaning pad layer **90** may include an additive which makes the cleaning pad layer **90** conductive. The conductive additive or filler may be, for example, conductive carbon-graphite particles or fibers, metal plated abrasive particulates or fibers, metallic particulates or fibers, which make the cleaning pad layer conductive. In the alternative, a well known conductive polymer material, such as polyanilenes, polypyrroles, polythiophenes, or other well known conductive polymer materials, may be used for the cleaning pad layer **90**. A conductive element **92** is shown in **FIG. 4** and may be implemented in various well known manners. The cleaning devices **80** shown are examples of the different cleaning devices that permit a prober/tester to detect the working surface of the cleaning device so that the tester/prober

device is able to operate in an automatic cleaning mode. It is desirable to operate the prober/tester in the automatic cleaning mode which reduces the involvement of humans (and reduces the errors and contaminants) and also increases the throughput of the prober/tester.

[0026] The cleaning device described above removes loose debris and adherent materials which are generated during a probing operation in a semiconductor manufacturing process. After repeated use, the polymer surface of the cleaning device accumulates a substantial amount of debris as well as various air-borne particulates, such as dust, skin, etc., found within a prober. The cleaning method provides a method for cleaning the surface of cleaning device so that the debris and particulate is removed from the cleaning device so that the cleaning device may be used again once it is cleaned.

[0027] **FIG. 5** is a flowchart illustrating a method **100** for cleaning the surface of a cleaning device in accordance with the invention. In order to perform the cleaning method described below, a user may preferably use the following materials:

[0028] Stereo Microscope

[0029] 150-mm (6-inch), 200-mm (8-inch) or 300-mm (12-inch) Probe Clean™ cleaning wafer

[0030] Prober polishing, or cleaning, plate onto which the cleaning polymer material has been installed.

[0031] Latex gloves

[0032] Liquid Isopropyl alcohol (IPA), greater than 99.5% pure, anhydrous, meets SEMI base spec standards, and is labeled "electronic grade"

[0033] Lint free clean room clothes

[0034] Natural fiber brush

[0035] Returning to **FIG. 5**, in step **102**, a careful visual inspection (preferably while wearing latex gloves to avoid contamination due to fingerprints, etc.) of the polymer working surface for any debris, defects, and damage such as tears, lifting around the edges, bubbles, shredded material, or significant surface discontinuities is performed. Preferably, the inspection is performed using a stereo microscope. During the visual inspection, it should be noted that there may be some manufacturing roller marks across the surface that can be expected. In accordance with the invention, inspection should be performed across the entire polymer surface with particular attention to the darker cleaning area to identify embedded probing debris such as aluminum "tails" and solder residuals. If excessive damage, e.g., torn area, shredded material, or other potentially hazardous to the probe card surface features, due to on-line cleaning or handling are observed in step **104**, the polymer should be discarded and replaced in step **106**. If embedded probing debris such as aluminum "tails" and solder residuals are observed within the polymer material in step **108**, then proceed to step **110** in which the embedded debris is removed with a very light natural fiber (i.e., sable, yak, etc.) brush. During the brushing, extreme caution must be taken during the operation to avoid tearing the polymer layer as these embedded particulates are removed. After brushing the polymer surface, perform a careful visual inspection of the polymer working surface for damage such as tears, shredded material, or surface discontinuities. If excessive damage due to cleaning or handling is observed, the polymer should be discarded. Once the brushing is completed and the embedded debris is removed, the polymer surface may be rinsed and dried in step **112** and **114** which will now be described.

[0036] In step **112**, if debris exists on the polymer working surface, gently flood the entire surface of the polymer with a liberal amount of IPA until it is covered with a thin layer of the liquid. Then in step **114**, with a folded lint-free clean-room cloth (since paper based materials, such as towels, tissue, TEX-Wipes, etc., may not remove the IPA uniformly from the surface of the polymer material) carefully and gently wipe the IPA across the surface of the wafer in one direction to avoid redistributing debris on the polymer surface. The rinsing operation can be performed using a standard rinse bottle; however, excessive fluid pressure should not be used as excessive fluid pressure will force the IPA into any surface discontinuities and into the polymer thickness. However, prolonged exposure to liquid IPA may cause the polymer to swell and form "bumps" across the surface. In order to avoid redepositing material onto the working surface of the cleaning device, use a fresh surface of the lint free cloth with each wipe and this can be accomplished by refolding the clean-room wipe or by using a new wipe.

[0037] In step **116**, the polymer surface may be dried with a low pressure blow-off across the polymer surface using an inert gas or compressed dry air (CDA). Preferably, the blow-off should not be directly perpendicular to the polymer surface. Furthermore, some forced air sources, such as pressurized canisters or "standard" house air, may contain hydrocarbon residues and are not recommended. Preferably, directing the air so that the IPA is blown from one side of the wafer to the other is suggested and using a diffuser is recommended to avoid driving the IPA into any of the surface discontinuities. In steps **118** and **120**, a visual inspection of the polymer working surface for smoothness, i.e., no surface "bumps" are visible, as well as any other damage such as tears, shredded material, or significant surface discontinuities is performed. As above, if these or any other surface defects are observed, the polymer should be discarded in step **122**. In step **124**, the polymer surface is air-dried for at least 1 to 2 hours (24 hours, if possible) to volatilize any residual IPA from the polymer surface. Preferably, oven drying should not be used to accelerate the IPA volatilization process. In step **126**, a final visual inspection of the polymer working surface for smoothness, i.e., no surface "bumps" are visible, as well as any other damage such as tears, shredded material, or significant surface discontinuities is performed. If these or any other surface defects are observed, the polymer should be discarded in step **128**. In step **130**, if the polymer surface is free from the aforementioned or any other defects, it can be re-installed into the prober according to recommended practices.

[0038] While the foregoing has been with reference to a particular embodiment of the invention, it will be appreciated by those skilled in the art that changes in this embodiment may be made without departing from the principles and spirit of the invention, the scope of which is defined by the appended claims.

1. A method for cleaning the surface of a cleaning device having a working surface that traps debris, the method comprising:

visually inspecting a working surface of the cleaning device to detect debris associated with the working surface, the debris including airborne debris and debris embedded into the working surface;

brushing the working surface with a brush when embedded debris is detected within the working surface;

rinsing the working surface to remove the debris from the working surface; and

drying the working surface following the rinsing.

2. The method of claim 1, wherein the drying step further comprises wiping the working surface with a cloth and blowing-off the working surface.

3. The method of claim 2, wherein the rinsing further comprises applying an isopropyl alcohol to the working surface.

4. An apparatus for cleaning a cleaning device, the cleaning device having a working surface on top of a substrate, the apparatus comprising:

a microscope for inspecting the working surface of the cleaning device to detect debris associated with the working surface;

a brush for brushing the working surface when debris embedded in the working surface is observed during the inspection of the working surface; and

a rinse device that is used to rinse the working surface to remove debris from the working surface.

5. The apparatus of claim 4, wherein the brush further comprises a natural fiber brush.

6. The apparatus of claim 4, wherein the working surface further comprises a polymer working surface.

7. The apparatus of claim 5, wherein the polymer working surface further comprises an elastomeric material.

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