

# Exhibit 10

# U.S. Patent No. 8,524,365

1. A nanoparticle comprising

The Samsung Q60R QLED TV is an exemplary LED TV (the "Samsung TV") that includes nanoparticles.



For example, the Samsung TV includes quantum dots (the "Samsung Quantum Dots")<sup>1</sup>.

<sup>1</sup> Upon information and belief, all Samsung QLED TVs listed in Exhibit 6 include the same Quantum Dots. For example, Samsung QLED TV's display stack includes a Blue LED and layer of Quantum Dots in a Quantum Dot Layer.

See e.g., "Environmentally Friendly Quantum Dots for Display Applications," Eunjoo Jang (SAIT, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slides 11, 16.

see also e.g., <https://www.techradar.com/news/samsung-qled-samsungs-latest-television-acronym-explained>;

see also e.g., <https://www.samsung.com/global/tv/blog/stained-glass-and-quantum-dot-technology/>;

see also e.g., <https://www.displaydaily.com/article/display-daily/future-of-quantum-dot-display-niche-or-mainstream>;

see also e.g., <https://www.techradar.com/news/samsung-qled-samsungs-latest-television-acronym-explained>.

Samsung's QD-OLED TV displays operate in substantially the same way in that they are comprised of a Blue OLED and Quantum Dot layer.

See e.g., <https://www.cnet.com/news/samsung-reportedly-working-on-quantum-dot-oled-tv-hybrid/>.

## Q60R Key Features



### 100% Color Volume

Over a billion shades of brilliant color—powered by Quantum Dots<sup>1</sup>—deliver our most realistic picture.



### Quantum Processor 4K

An intelligently powered processor that upscales content for sharp detail and refined color.



### Ambient Mode™

Complements your space by turning a blank screen into enticing visuals or at-a-glance news.<sup>2</sup>



### Quantum HDR 4X

Shades of color and detail leap off the screen in dark and bright scenes specific conditions.<sup>3</sup>

See e.g., <https://www.samsung.com/us/televisions-home-theater/tvs/qled-4k-tvs/43-class-q60-qled-smart-4k-uhd-tv-2019-qn43q60rafxza/>.

### Quantum Dots

QLED displays true colors (over a billion shades to be exact), even in the brightest scenes with 100% Color Volume.<sup>1</sup> So whether you're watching survival shows that take place on secluded beaches or nature documentaries that explore every corner of the planet, you'll experience rich cinematic views that will make you feel like you're there.

See e.g., <https://www.samsung.com/us/televisions-home-theater/tvs/qled-tv/technology/>.

The Samsung Quantum Dots used in the Samsung TV are nano-particles.

## QLED Technology

**New Alloy Quantum Dot**  
Next-generation display of nano-sized materials

**One Material, One Billion Colors**  
Nanoparticles change light into one billion colors

**The Perfect Material for TV**  
Reproduce everything that the human eye can see

Gradient ZnSeS shell  
New Metal Implemented Core  
New Metal Implemented Shell

2 nano 3 nano 4 nano

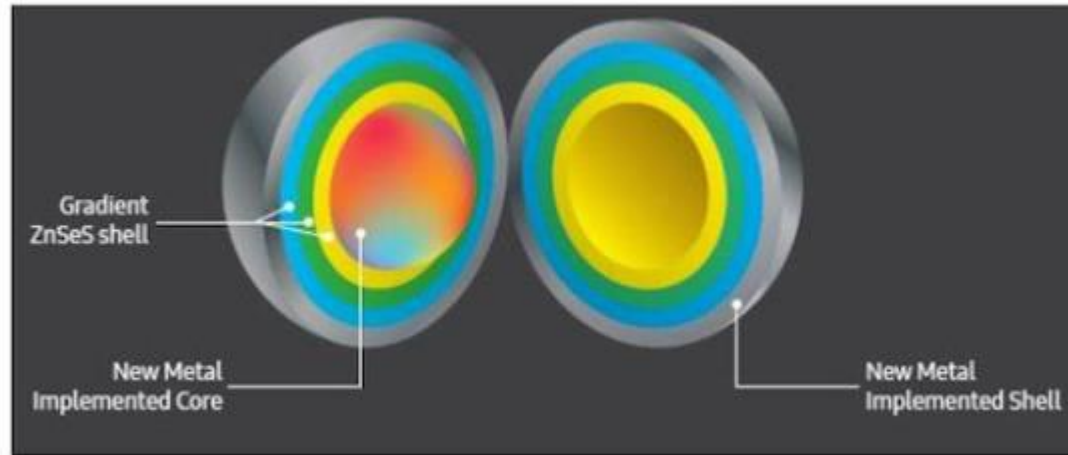
True RGB

Energy Efficiency

Durability

See e.g., <https://news.samsung.com/global/how-qled-achieves-excellence-in-picture-quality>;  
See also e.g., <https://www.hitechcentury.com/samsungs-next-gen-qled-tv-showcased-at-sea-forum-2017/>;

U.S. Patent No. 8,524,365: Claim 1  
"1. A nanoparticle comprising"



A diagram showing the unique Quantum Dot design Samsung is using in its 2017 QLED TVs.

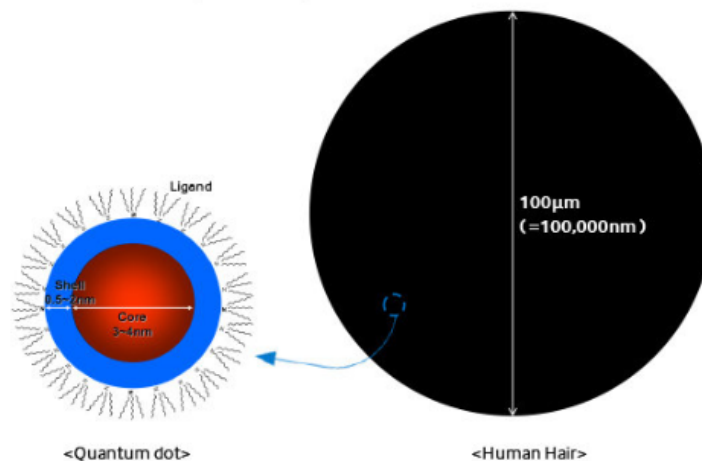
PHOTO: SAMSUNG

See e.g., <https://www.forbes.com/sites/johnarcher/2017/09/19/what-is-qled-and-why-does-it-matter/#732982817fb3>.

## What Is 'Quantum Dot?'

Quantum dots are nano-sized crystals made of semiconductor materials. A nanometer (nm) is one billionth of a meter, which means these extra-small particles are smaller than 1/10,000 of a single strand of human hair.\*

Width Comparison: Quantum Dot vs. Human Hair



Quantum dots can be made of different kinds of elements, but when they're regulated down to a size small enough, they possess physical properties that make them suitable for many different applications. For example, quantum dots are very efficient in absorbing and then emitting light. Based on this quality, quantum dots are being researched in areas such as solar panels, bioimaging, and, of course, display.

See e.g., <https://news.samsung.com/za/why-are-quantum-dot-displays-so-good>.

### **What the what?**

Quantum dots are microscopic nanocrystals that glow a specific wavelength (i.e. color) when given energy. The exact color produced by the QD depends on its size: larger for longer wavelengths (redder colors), smaller for shorter wavelengths (bluer). That's a bit of an oversimplification, but that's the basic idea.

Specific wavelengths of color is what we need to great an image on a television. Using the three primary colors of red, green, and blue, we can mix a full rainbow of teals, oranges, yellows, and more.

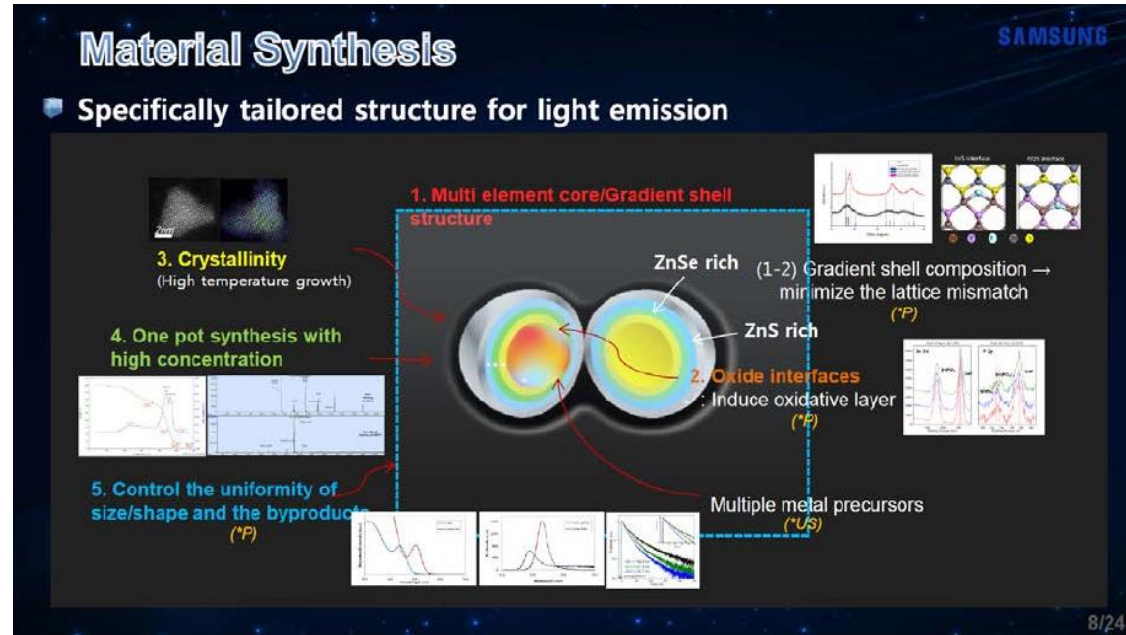
See e.g., <https://www.cnet.com/news/quantum-dots-how-nanocrystals-can-make-lcd-tvs-better/>.

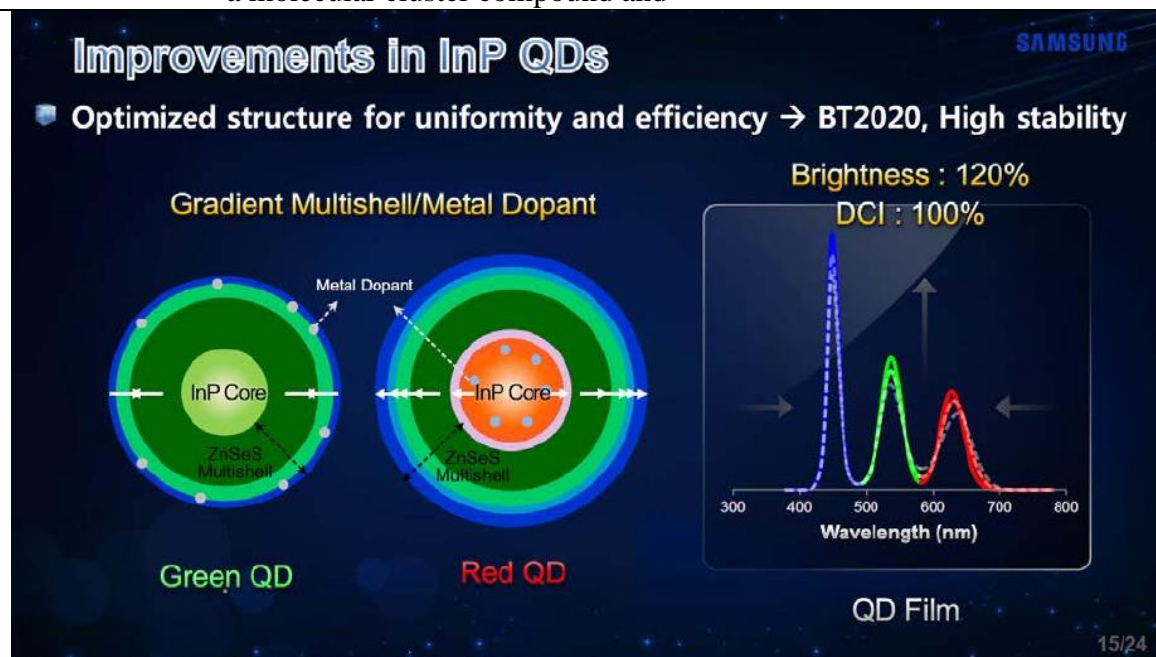


a molecular cluster compound and

The Samsung Quantum Dots include a molecular cluster compound.

For example, the Samsung Quantum Dots include an InP-based core that is surrounded by an oxide layer and two Zn-based outer shells.

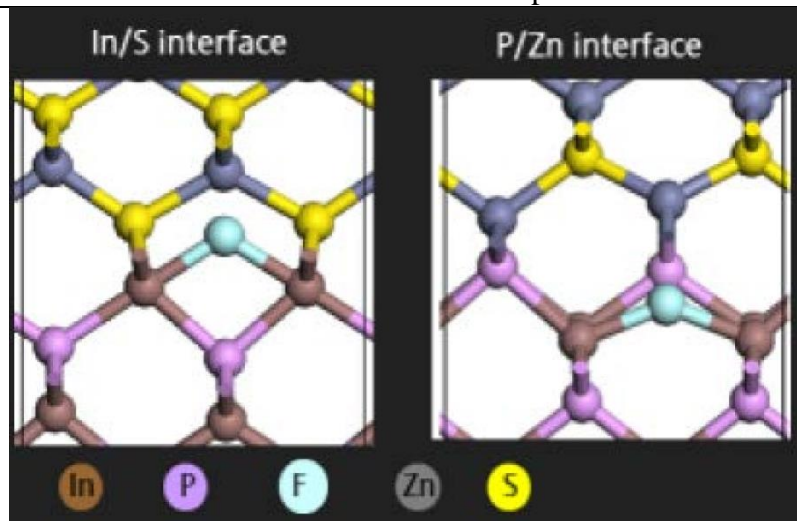




See e.g., “Environmentally Friendly Quantum Dots for Display Applications,” Eunjoo Jang (Samsung Advanced Institute of Technology, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slides 8, 15.

Samsung demonstrates that a molecular interface exists between In, P, Zn, and S within their Quantum Dot cores.

U.S. Patent No. 8,524,365: Claim 1  
"a molecular cluster compound and"



See, "Environmentally Friendly Quantum Dots for Display Applications," Eunjoo Jang (Samsung Advanced Institute of Technology, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slide 8.

This means that the InP core is formed on a molecular cluster compound including, at least, Zn and S, which are ions from groups 12 and 16.

For example, S is an ions from group 16 of the periodic table. Group 16 elements include: O, S, Se, Te, Po, and Uuh. Further, Zn is an ion from group 12 of the periodic table. Group 12 elements include: Zn, Cd, Hg, and Cn.

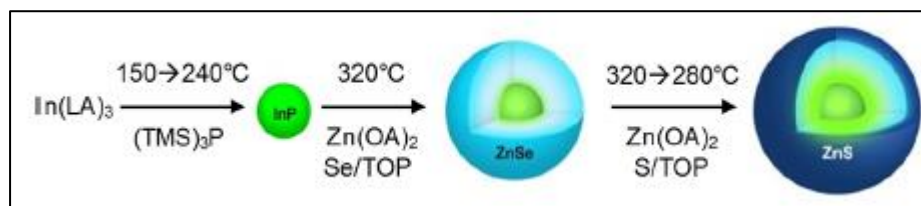
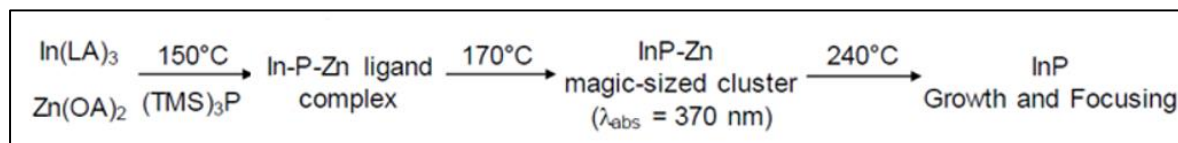
Group →	12	13	14	15	16
2		5 B	6 C	7 N	8 O
3		13 Al	14 Si	15 P	16 S
4	30 Zn	31 Ga	32 Ge	33 As	34 Se
5	48 Cd	49 In	50 Sn	51 Sb	52 Te
6	80 Hg	81 Tl	82 Pb	83 Bi	84 Po
7	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh

See e.g., <https://www.jobilize.com/nanotechnology/course/optical-properties-of-group-12-16-ii-vi-semiconductor-nanoparticles>.

Further, upon information and belief, Samsung's Quantum Dots are formed using the following synthesis process, which demonstrates that, at least,  $\text{In(LA)}_3$ ,  $\text{Zn(OA)}_2$ , and  $(\text{TMS})_3\text{P}$  are precursor species comprised of ions contained in Samsung's growing nanoparticle core.

**"We injected  $(\text{TMS})_3\text{P}$  at 150 °C in the presence of both indium laurate ( $\text{In(LA)}_3$ ) and zinc oleate ( $\text{Zn(OA)}_2$ ) precursors. At this mild temperature the In – P – Zn ligand complexes were first formed, and then they were converted to InP MSCs as the temperature increased to 170 °C, showing a sharp absorption peak at 370 nm."**

See "Bright and Uniform Green Light Emitting InP/ZnSe/ZnS Quantum Dots for Wide Color Gamut Displays," ACS Appl. Nano Mater. 2019, 2, 1496–1504, Eunjoo Jang et. al. (Samsung Advanced Institute of Technology, Samsung Electronics) (Exhibit 13), at 1497<sup>2</sup>.



*Id.*, see also "Bright and Uniform Green Light Emitting InP/ZnSe/ZnS Quantum Dots for Wide Color Gamut Displays," ACS Appl. Nano Mater. 2019, 2, 1496–1504, Eunjoo Jang et. al. (Samsung Advanced Institute of Technology, Samsung Electronics), Supporting Information (Exhibit 14) at S-3.

<sup>2</sup> Dr. Eunjoo Jang of Samsung's Advanced Institute of Technology (SAIT) is responsible for the synthesis of Samsung's Quantum Dots. See e.g., <https://news.samsung.com/global/quantum-dot-artisan-dr-eunjoo-jang-samsung-fellow>. SAIT is Samsung's Research and Development Center. See e.g., <https://www.sait.samsung.co.kr/saithome/mobile/research/what.do>. The cited paper—authored by Eunjoo Jang—describes a method for synthesizing InP/ZnSe/ZnS quantum dots. As previously shown, Samsung describes its quantum dots as comprising a core-shell structure of InP/ZnSe/ZnS. See e.g., "Environmentally Friendly Quantum Dots for Display Applications," Eunjoo Jang (Samsung Advanced Institute of Technology, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slides 8.

U.S. Patent No. 8,524,365: Claim 1  
"a molecular cluster compound and"

This means that the InP core is formed on a molecular cluster compound including, at least, Zn, S and O, which are ions from groups 12 and 16.

For example, S and O are ions from group 16 of the periodic table. Group 16 elements include: O, S, Se, Te, Po, and Uuh. Further, Zn is an ion from group 12 of the periodic table. Group 12 elements include: Zn, Cd, Hg, and Cn.

Group →	12	13	14	15	16
↓ Period					
2		5 B	6 C	7 N	8 O
3		13 Al	14 Si	15 P	16 S
4	30 Zn	31 Ga	32 Ge	33 As	34 Se
5	48 Cd	49 In	50 Sn	51 Sb	52 Te
6	80 Hg	81 Tl	82 Pb	83 Bi	84 Po
7	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh

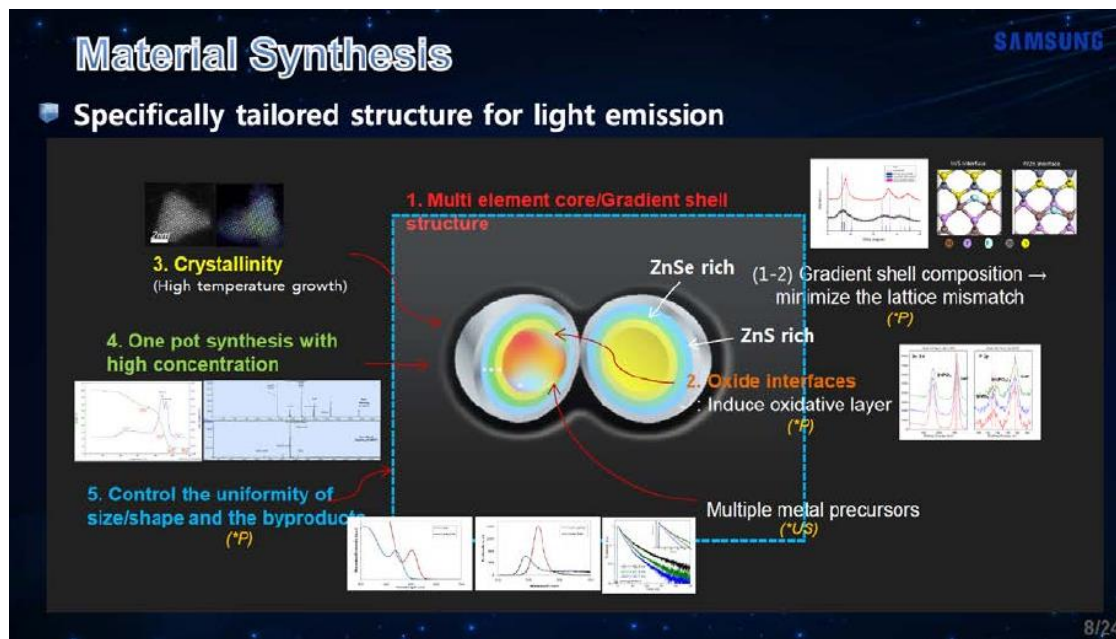
See e.g., <https://www.jobilize.com/nanotechnology/course/optical-properties-of-group-12-16-ii-vi-semiconductor-nanoparticles>.

"a core semiconductor material disposed on the molecular cluster compound,"

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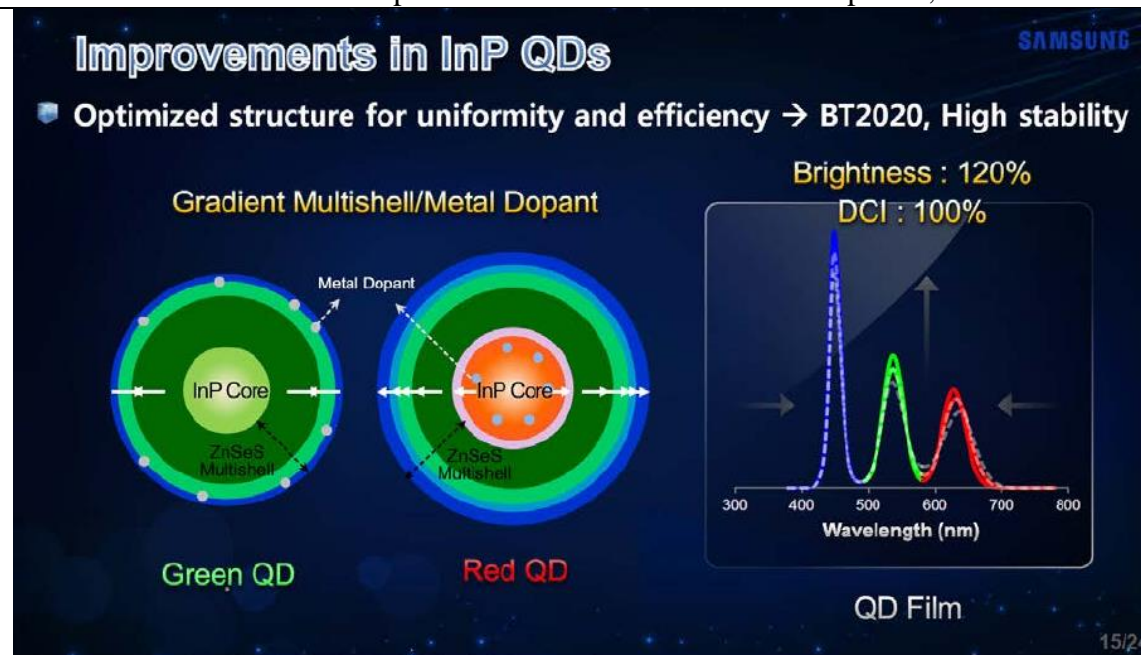
The Samsung Quantum Dots include a core semiconductor material disposed on the molecular cluster compound.

For example, the Samsung Quantum Dots include an InP-based core that is surrounded by an oxide layer and two Zn-based outer shells.





"a core semiconductor material disposed on the molecular cluster compound,"

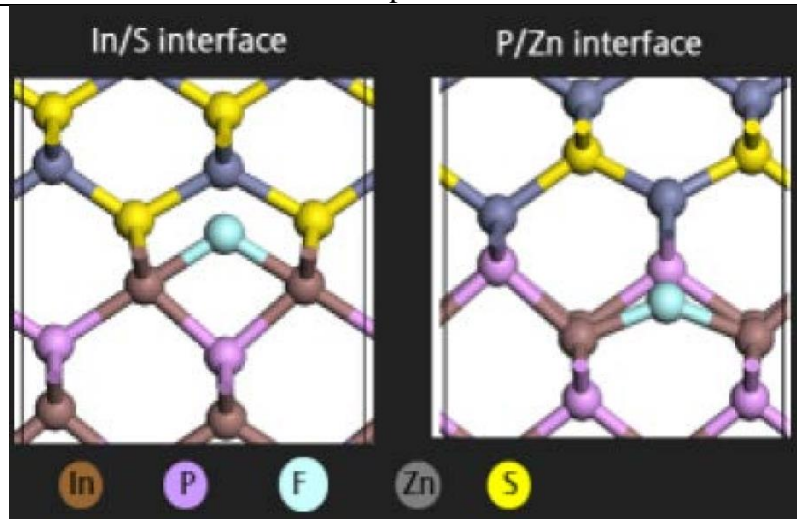


See e.g., “Environmentally Friendly Quantum Dots for Display Applications,” Eunjoo Jang (Samsung Advanced Institute of Technology, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slides 8, 15.

The InP semiconductor core is provided on the molecular cluster compound.

For example, as shown previously, Samsung demonstrates that a molecular interface exists between In, P, Zn, and S within their InP Quantum Dot cores.

"a core semiconductor material disposed on the molecular cluster compound,"



**Material Synthesis**

**Specifically tailored structure for light emission**

1. Multi element core/Gradient shell structure

2. Oxide interfaces: Induce oxidative layer

3. Crystallinity (High temperature growth)

4. One pot synthesis with high concentration

5. Control the uniformity of size/shape and the byproducts

ZnSe rich

ZnS rich

Multiple metal precursors

Gradient shell composition → minimize the lattice mismatch

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See e.g., “Environmentally Friendly Quantum Dots for Display Applications,” Eunjoo Jang (Samsung Advanced Institute of Technology, Samsung Electronics), Quantum Dot Forum 2018 Presentation (Exhibit 12) at Slide 8.

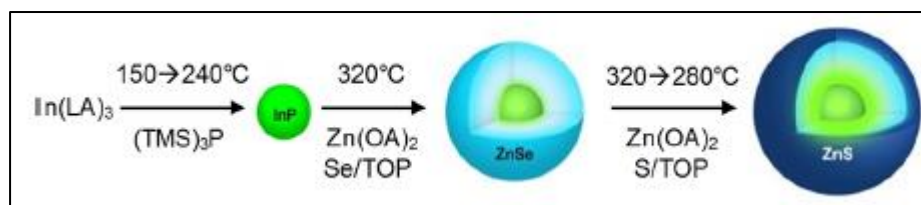
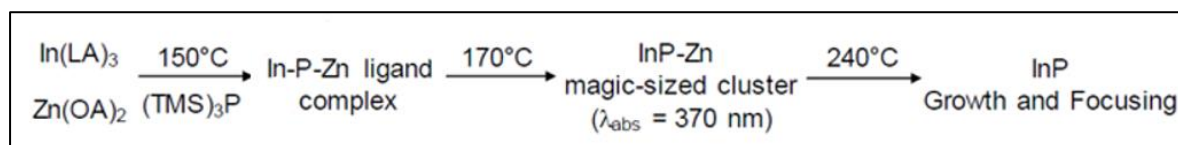


"a core semiconductor material disposed on the molecular cluster compound,"

Further, upon information and belief, Samsung's Quantum Dots are formed using the following synthesis process, which demonstrates that, at least,  $\text{In(LA)}_3$ ,  $\text{Zn(OA)}_2$ , and  $(\text{TMS})_3\text{P}$  are precursor species comprised of ions contained in Samsung's growing nanoparticle core.

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*See e.g.*, “Bright and Uniform Green Light Emitting InP/ZnSe/ZnS Quantum Dots for Wide Color Gamut Displays,” ACS Appl. Nano Mater. 2019, 2, 1496–1504, Eunjo Jang et. al. (Samsung Advanced Institute of Technology, Samsung Electronics) (Exhibit 13), at 1497.



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“wherein the semiconductor material comprises one or more elements not comprised within the molecular cluster compound.”

wherein the semiconductor material comprises one or more elements not comprised within the molecular cluster compound.

The semiconductor material in the Samsung Quantum Dots comprises one or more elements not comprised within the molecular cluster compound.

For example, the InP-based semiconductor core in the Samsung Quantum Dots includes ions from groups 13 and 15 of the periodic table. Group 13 elements include: B, Al, Ga, In, Tl, and Uut. Group 15 elements include: N, P, As, Sb, Bi, and Uup.

**Icosagens**  
Boron Family  
Group 13  
aka Triels

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H																	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo
				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	
				Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	

See e.g., <https://www.askiitians.com/iit-jee-s-and-p-block-elements/boron-family.html>.

**Pnictogens**  
Nitrogen Family  
Group 15

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
1	H																	He		
2	Li	Be													B	C	N	O	F	Ne
3	Na	Mg													Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo		
				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb			
				Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No			

See e.g., <https://periodictableprojectblog.wordpress.com/2016/02/14/group-15/>