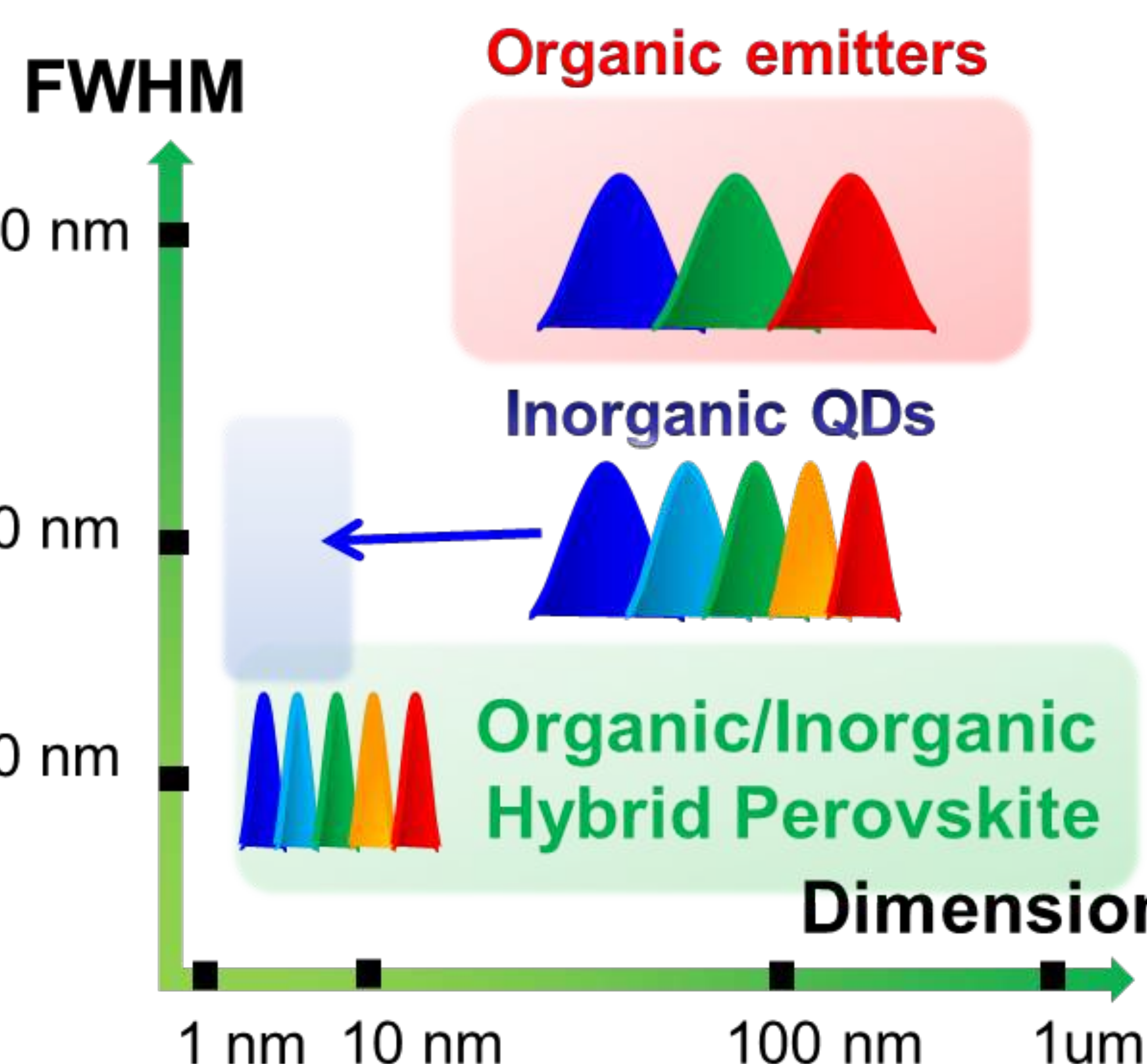


Metal Halide Perovskite Nanoparticle Synthesis and Application Technology

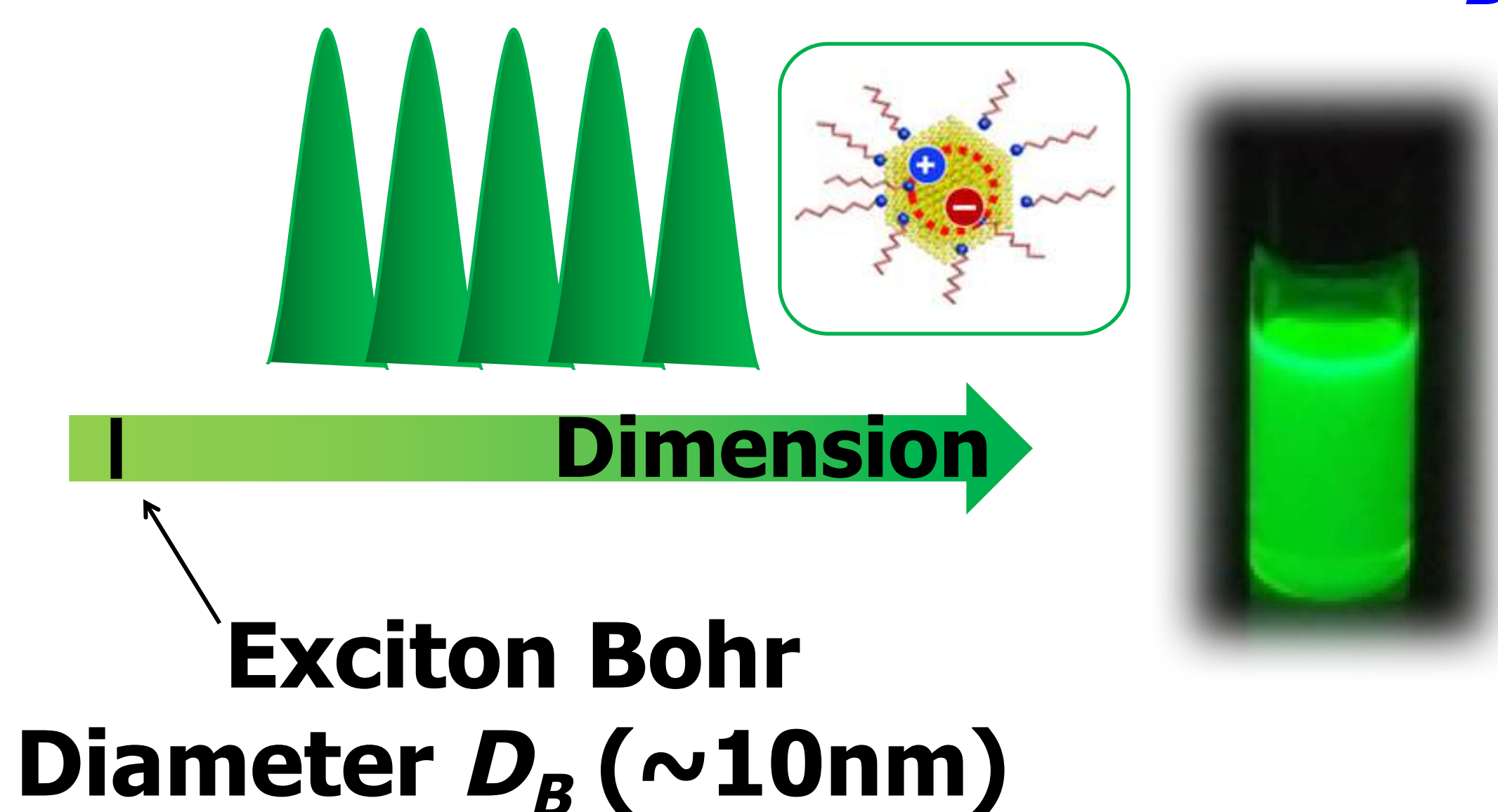
Research Background



- Organic emitters have low color purity, complex synthesis route and low charge carrier mobility.
- Inorganic quantum dot (QD) emitters have deep energy level, size-dependent color-purity and high material costs.
- Metal halide perovskite emitters which have size-independently high color-purity and low material cost should be developed.
- However, metal halide perovskite shows low photoluminescence quantum efficiency (PLQE) at room temperature (RT).

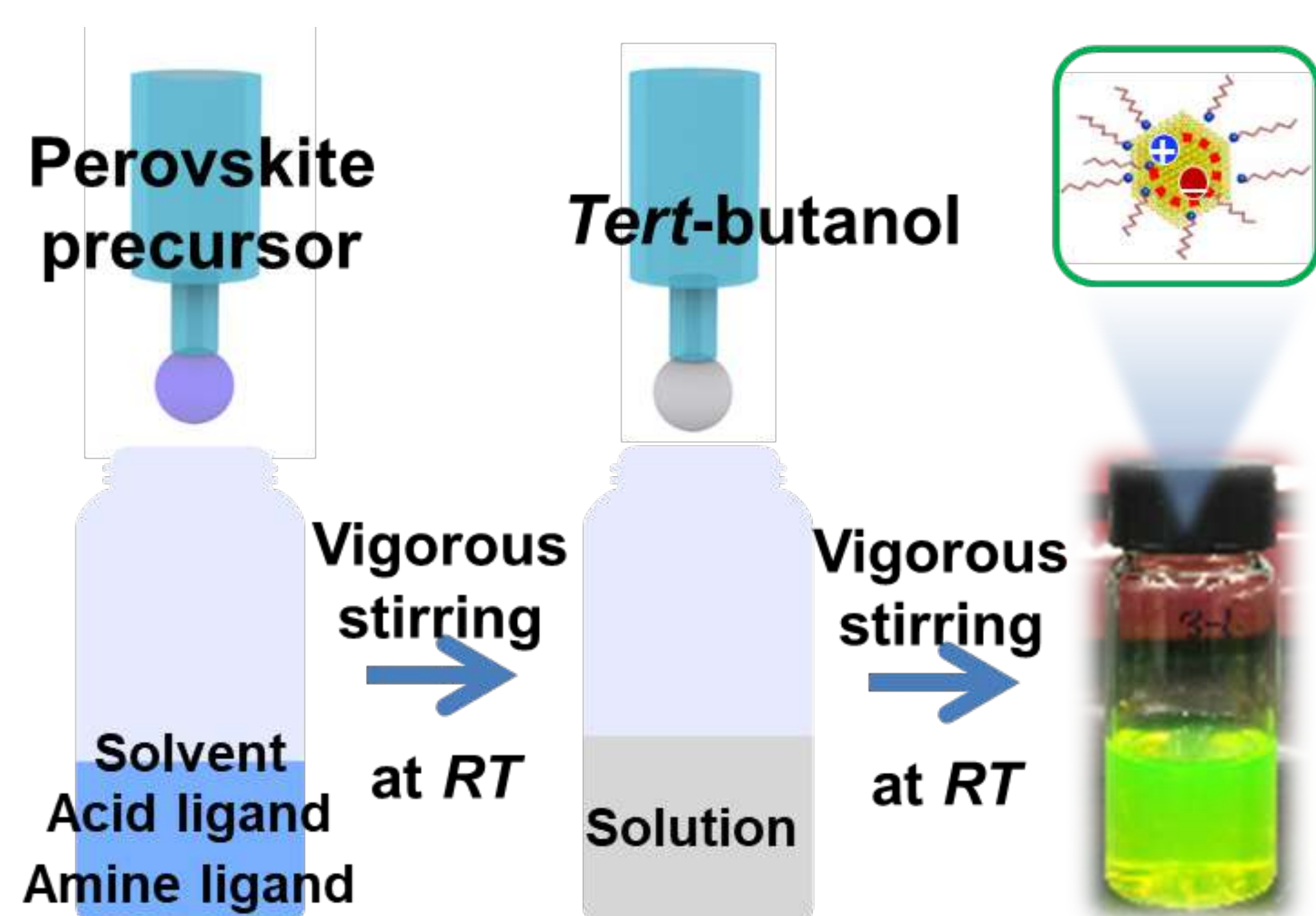
Technology

Perovskite Nanoparticles ($\geq D_B$)

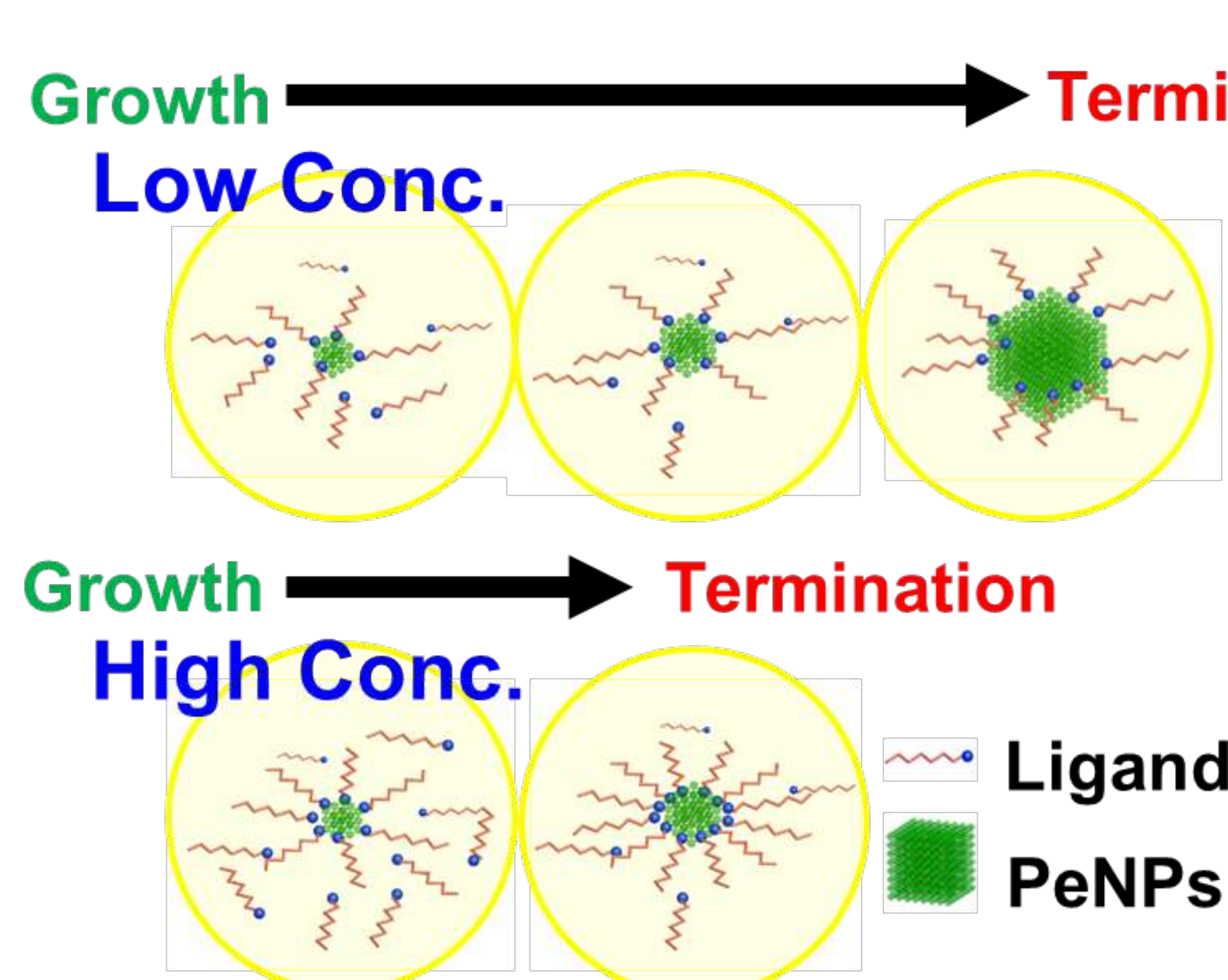


- Perovskite nanoparticle (NPs) with a dimension $> D_B$ (regime beyond quantum size) have size-insensitively high color-purity (full width at half maximum (FWHM) ~ 20 nm) and wavelength of emitted light, thus, we do not need to consider size distribution.
- Perovskite NPs manage the recombination of excitons occurred at surface traps and inside the NPs, thus show high PLQE $> 70\%$.

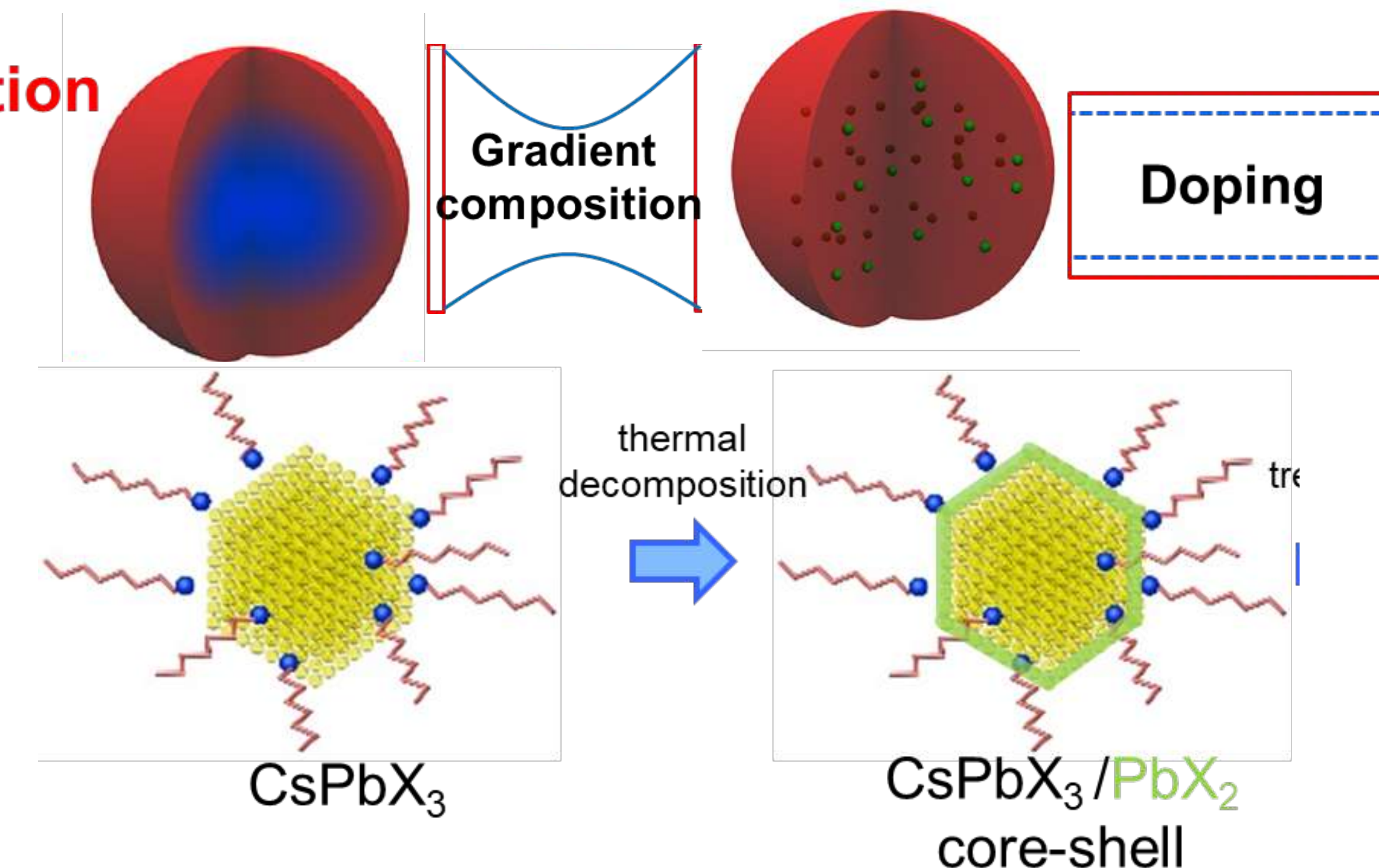
Synthesis of Perovskite NPs



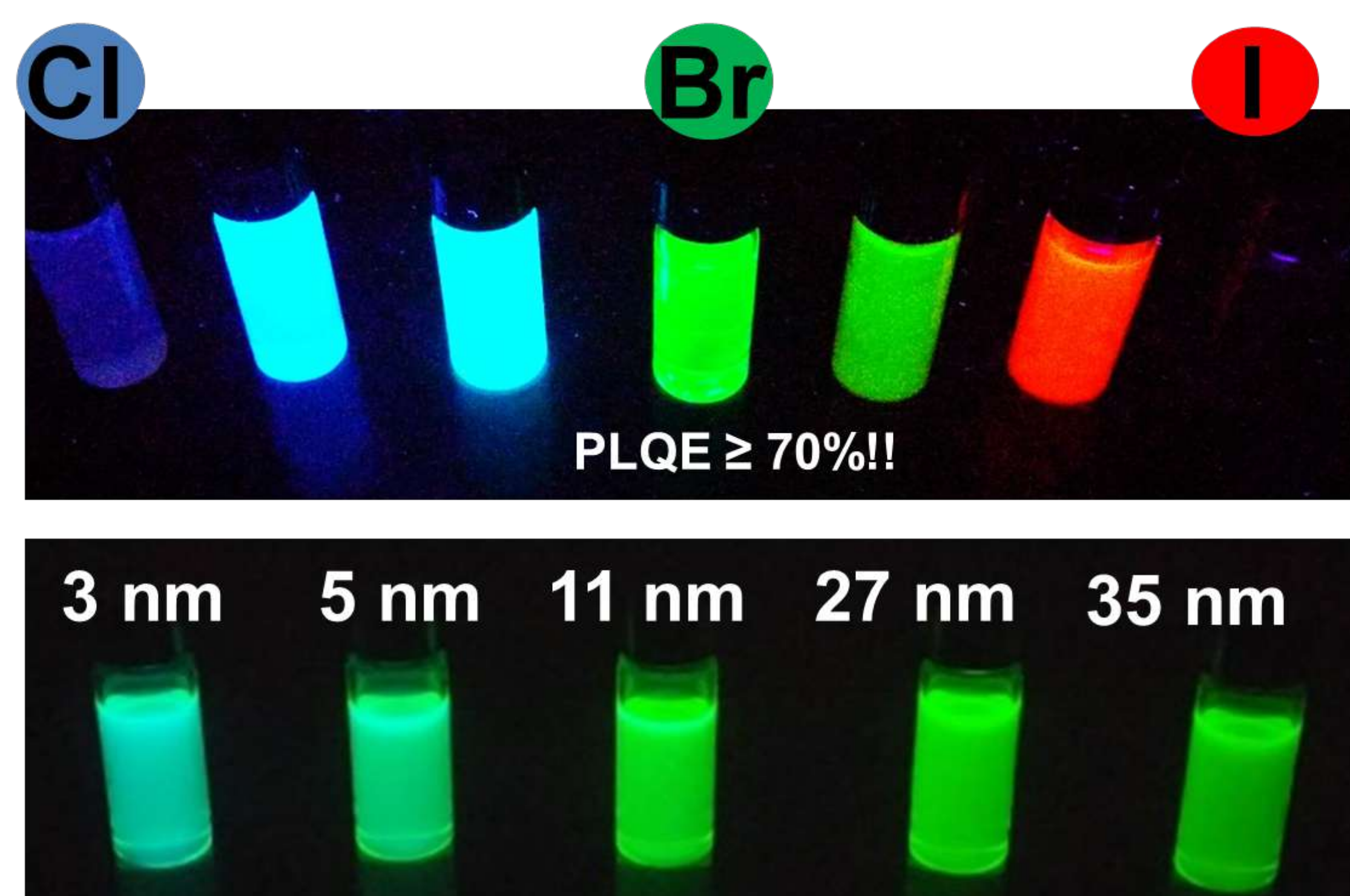
Size-control



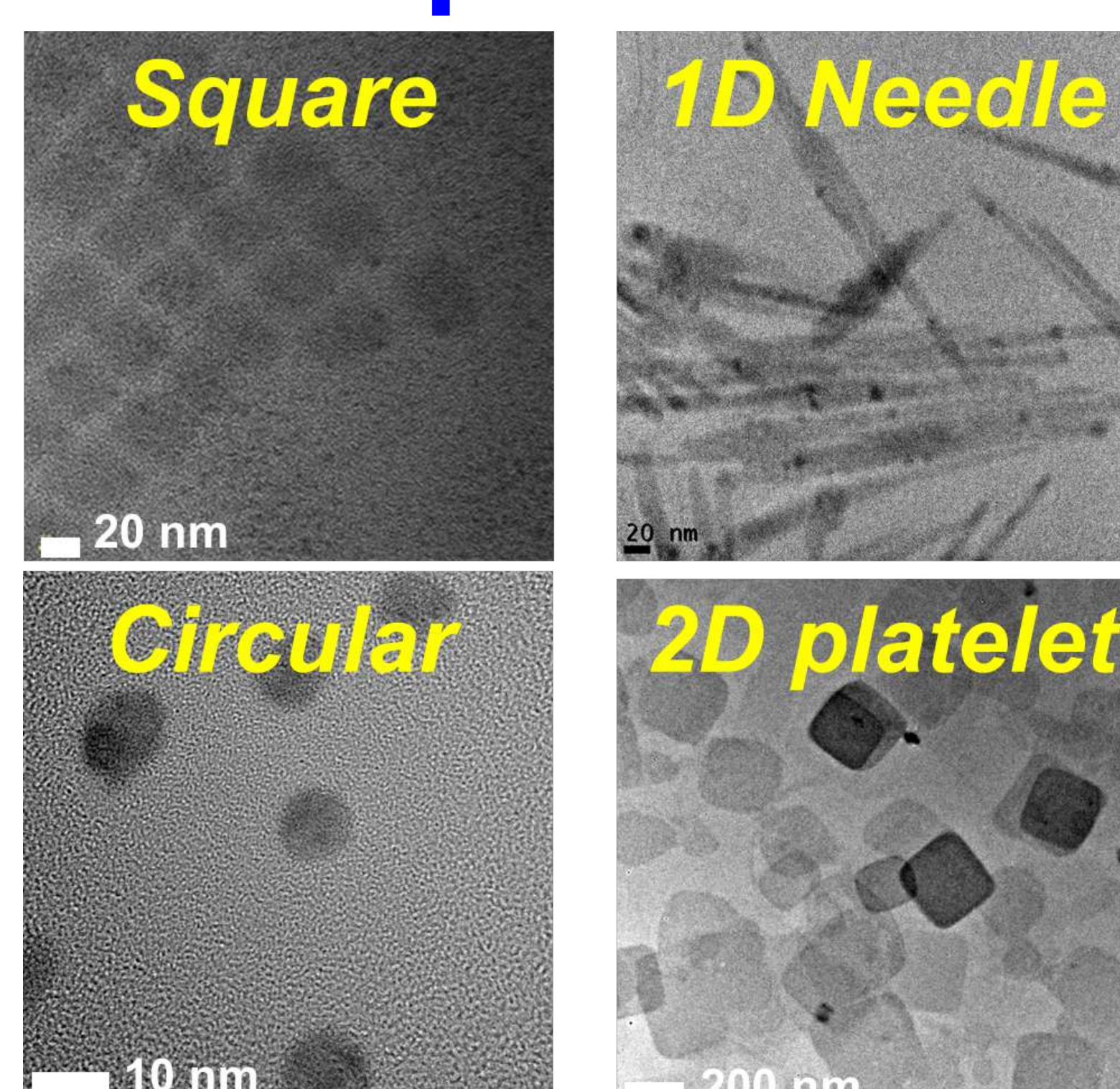
Structure-control



Color-tuning



Shape-control



- Perovskite NPs can be easily synthesized at room temperature.
- Size, shape, structure and emitting color of perovskite NPs can be controlled by ligand change, composition control and synthesis temperature.

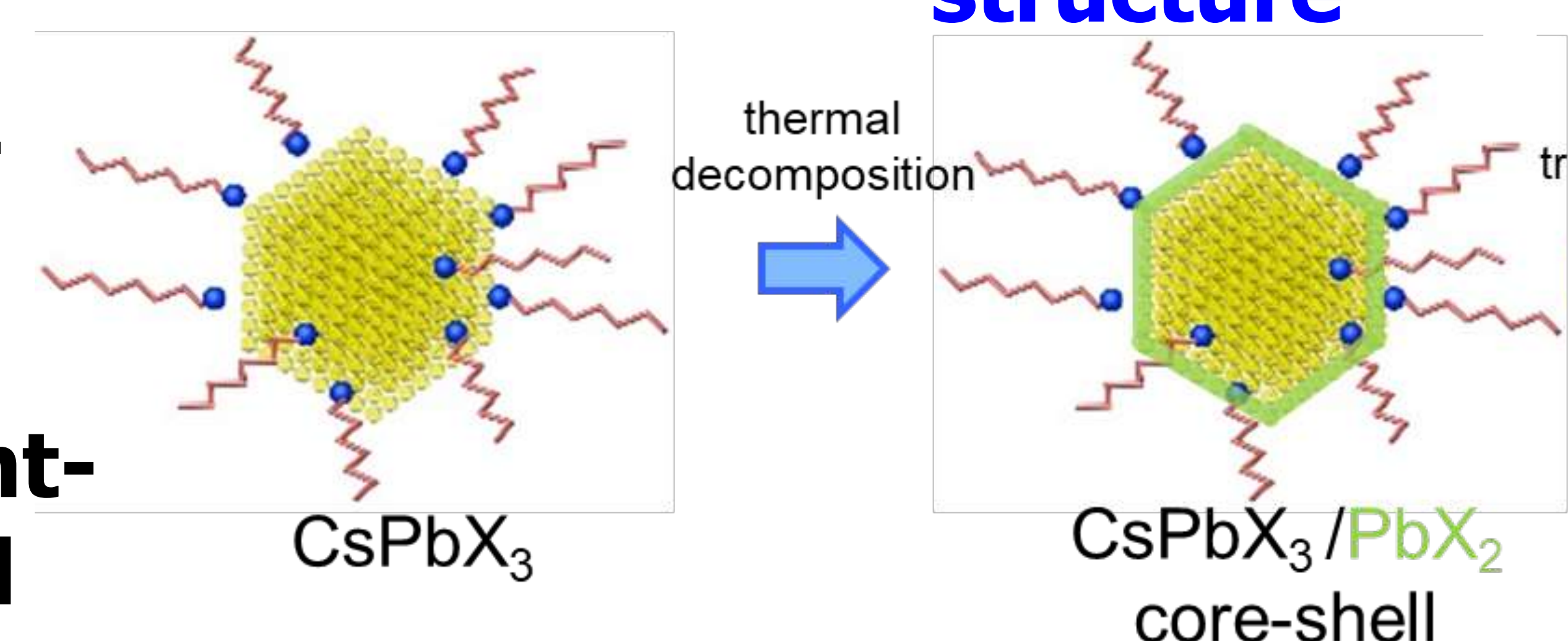
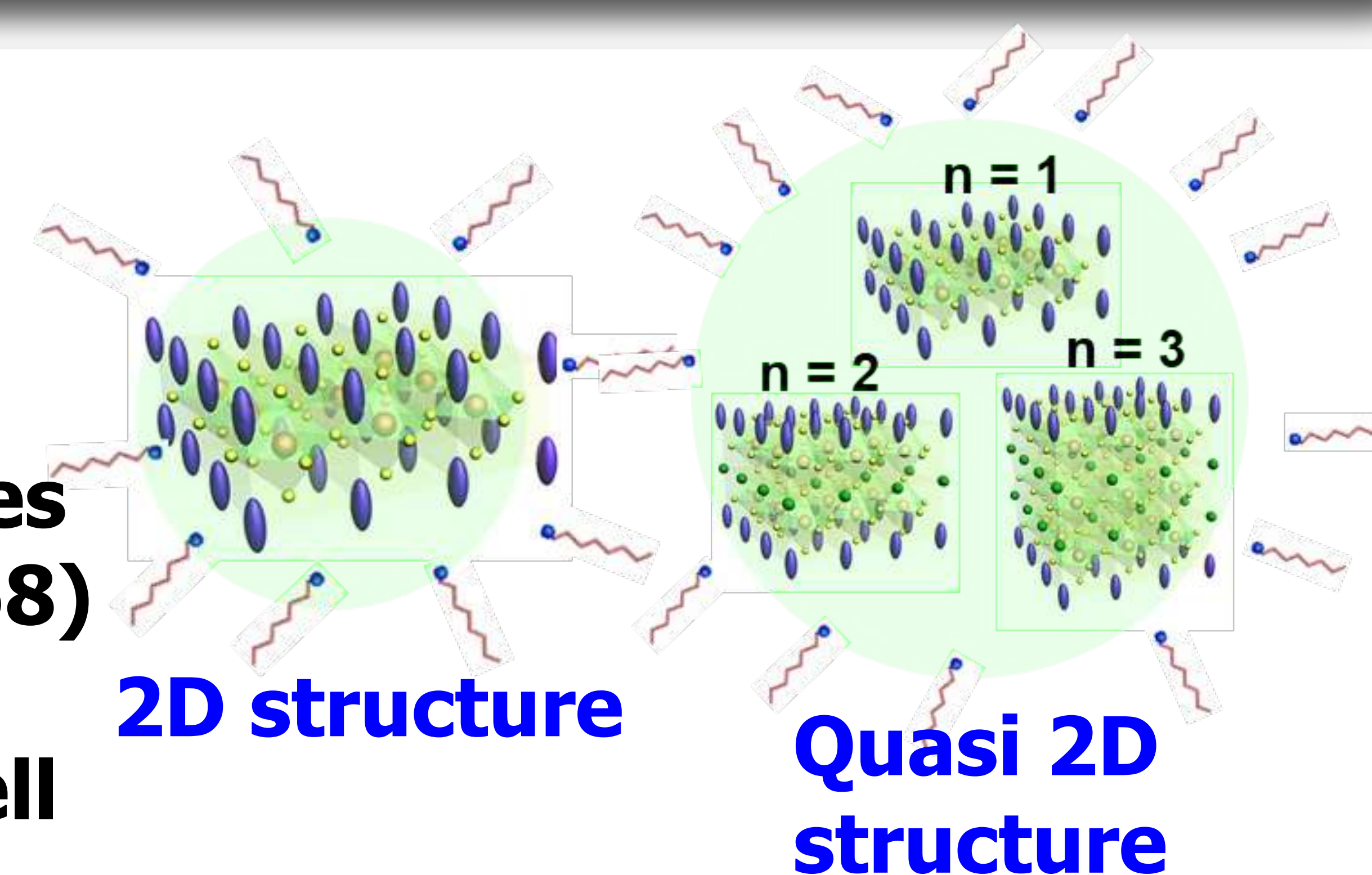
Metal Halide Perovskite Nanoparticle Synthesis and Application Technology

Advantages and Prospect

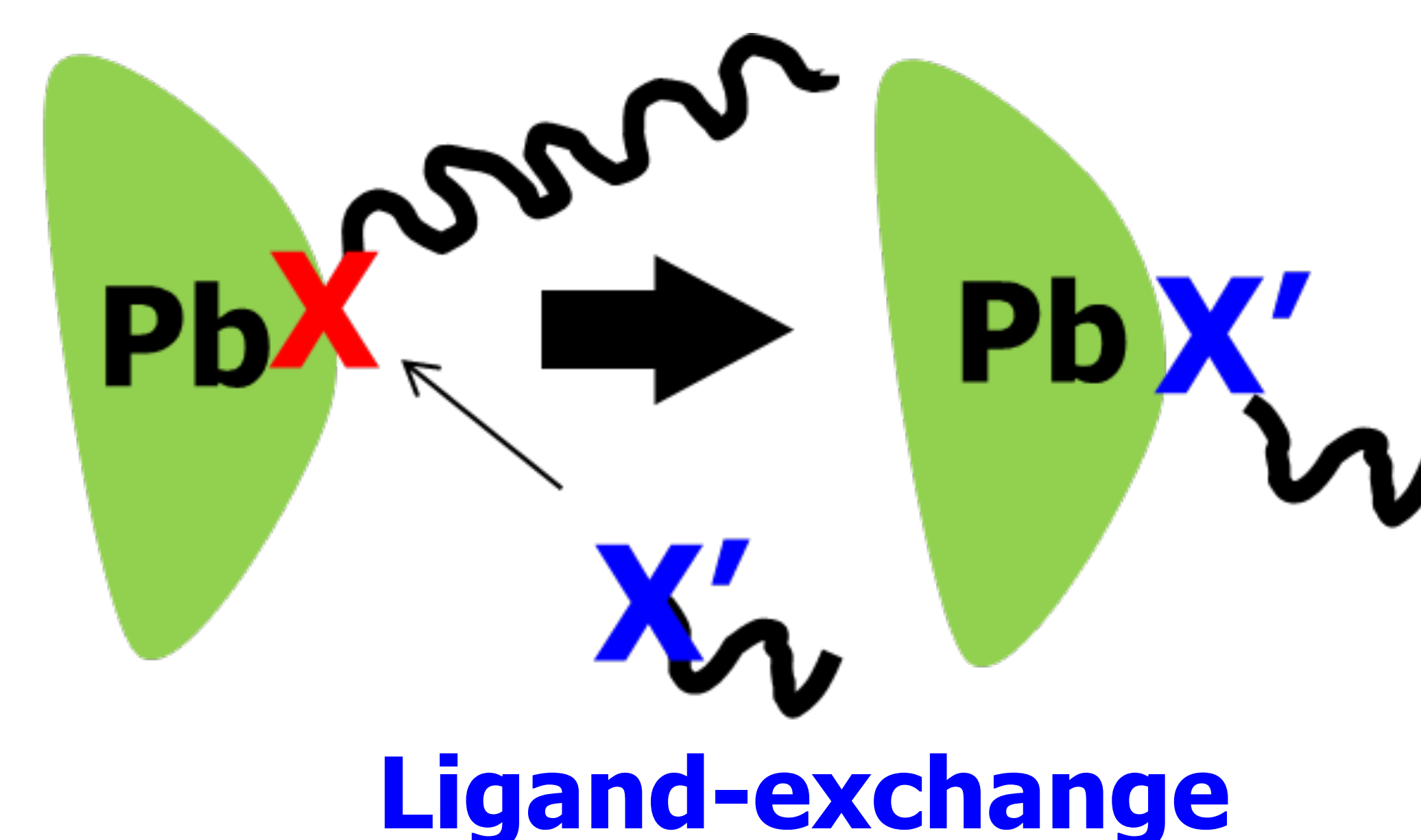
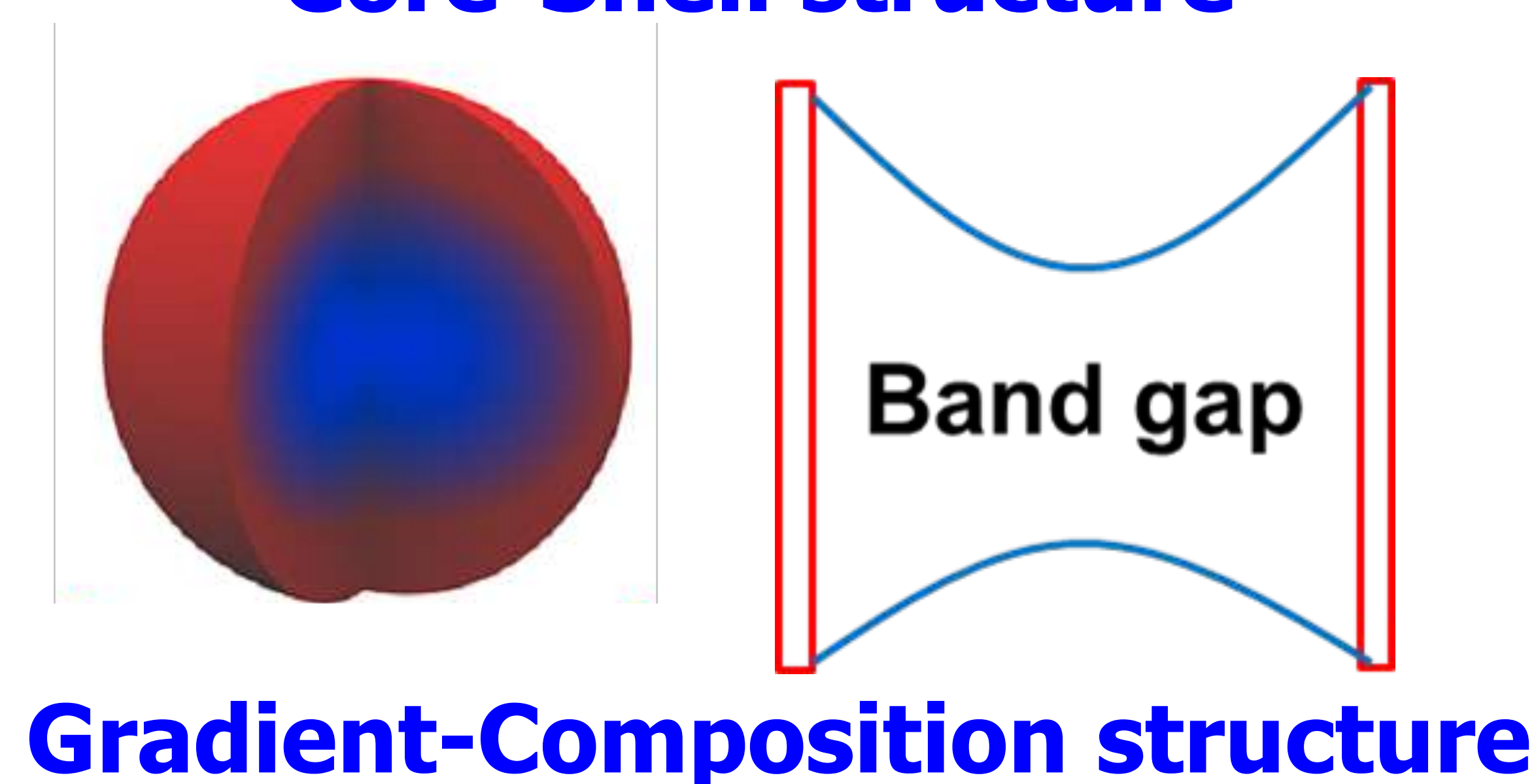
- Perovskite nanoparticle (NPs) $> D_B$ (regime beyond quantum size) have size-insensitively high color-purity (FWHM ~ 20 nm) and PLQE; these can overcome the size-dependent emission problems of perovskite QDs and inorganic QDs.
- Perovskite NPs can be simply synthesized at room temperature in air and thus, suitable for mass-production.
- Perovskite precursors have much lower price (6,000 won/g) than organic emitters (1,200,000 won/g) and inorganic QD emitters (3,000,000 won/g).
- Perovskite NPs with simple synthesis process and low material cost have great possibility in industrialization.

Patents

- Organic/inorganic hybrid perovskite nanocrystalparticle emitters with 2 dimensional structure, method of manufacturing the same and electroluminescence devices using the same (10-2014-0153972, PCT/KR2015/011958)
- Perovskite nanocrystal particle emitters having core-shell structure, method of manufacturing the same and electroluminescence devices using the same (10-2015-0156175, PCT/KR2015/011960)
- Perovskite nanocrystal particle emitters having gradient-alloy structure, method of manufacturing the same and electroluminescence devices using the same (10-2015-0156170, PCT/KR2015/011962)
- Method of manufacturing perovskite nanocrystal particle emitters with substituted organic ligand, nanocrystal particle emitters manufactured the same and electroluminescence devices using the same (10-2015-0156179, PCT/KR2015/011961)
- Perovskite light emitting element for the light emitting layer and a method of manufacturing and using the same Perovskite light emitting element (10-2015-0156173, PCT/KR2015/011963)



Core-Shell structure





Metal Halide Perovskite Nanoparticle Synthesis and Application Technology

Papers

- Metal halide perovskite light emitters, *Proc. Natl. Acad. Sci. U S A* 2016, 113, 11694.
- High Efficiency Perovskite Light-Emitting Diodes of Ligand-Engineered Colloidal Formamidinium Lead Bromide Nanoparticles, *Nano Energy* 2017, 38, 51.
- Highly Efficient Light-Emitting Diodes of Colloidal Metal-Halide Perovskite Nanocrystals Beyond Quantum Size, *ACS Nano* 2017, 11, 6586.

Applications

Curved TV



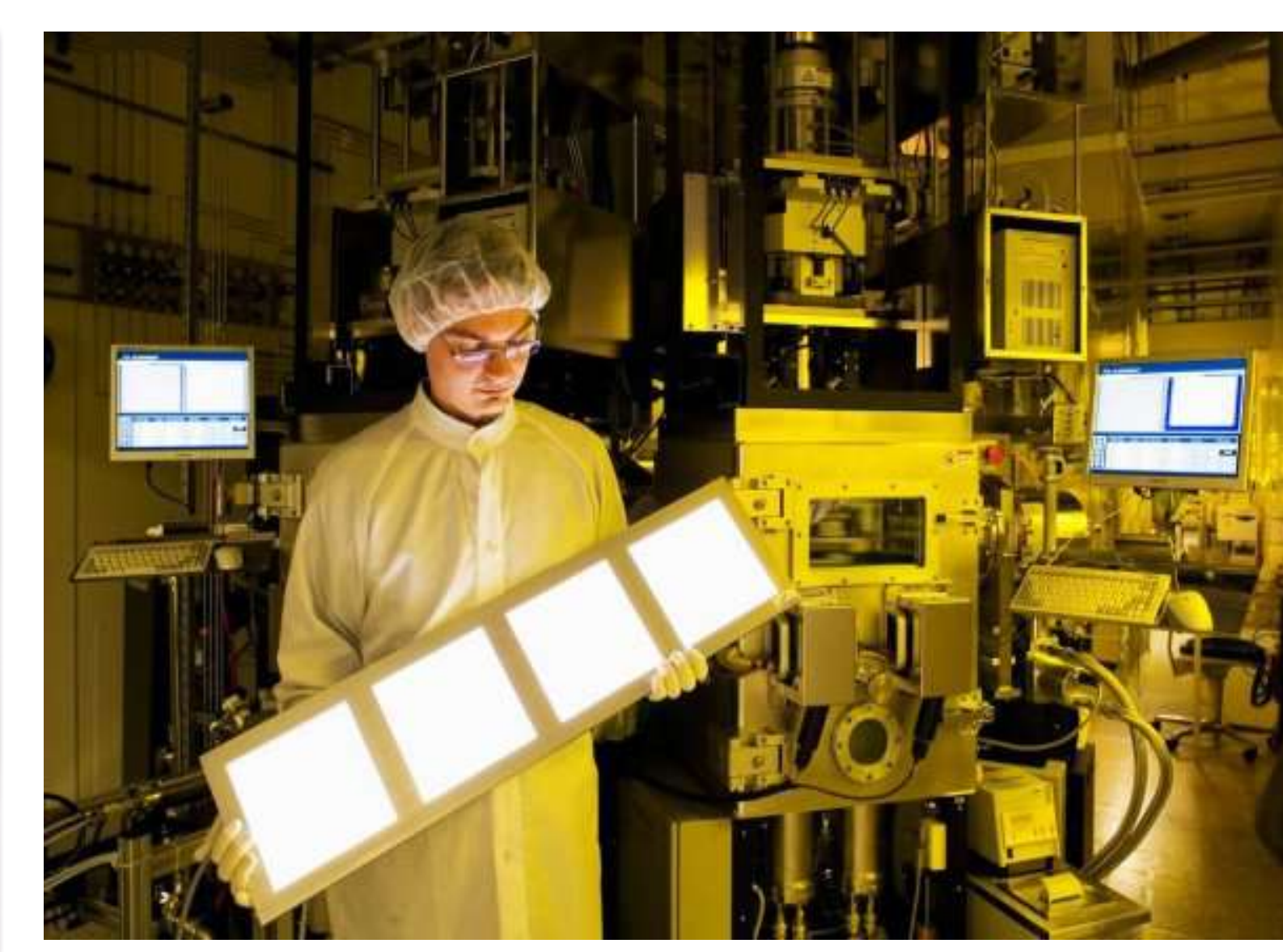
Digital screens and billboards



Smart phones



Flexible lighting



Automobile displays

Flexible displays

Laser

Illumination

Related Company

- Display company
- Lighting company
- Light-emitting film company

Source Technology

- We initially registered the 8 granted core-patents in Korea (2014.11) and applied them in other countries.
- We have published several related patents in Korea and other countries.