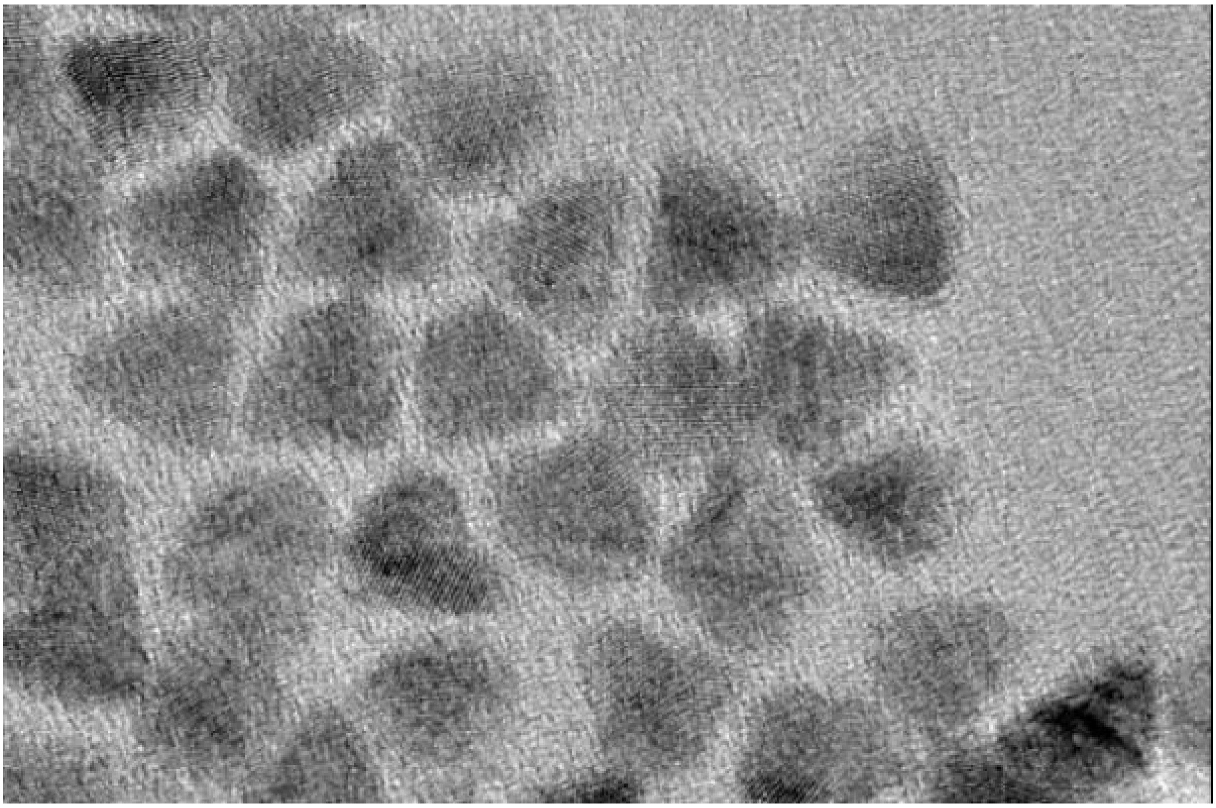

From a sphere to a tetrahedron: a novel quantum dot growth strategy for SWIR detection

ICFO researchers have proposed a novel method to synthesize indium arsenide colloidal quantum dots for SWIR detection that overcomes previous limitations. Presented in Advanced Materials, this safe and economic alternative to conventional synthesis methods paves the way for high-performance SWIR optoelectronics.

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Short-wave infrared (SWIR) light can be used to image through smoke and fog as well as at night and from a remote location, all while keeping the eyes safe. But how can we unlock all these applications? Colloidal quantum dots (tiny semiconductors that behave like a single atom) made of indium arsenide (InAs CQDs) may hold the answer. They offer high tunability, comply with hazardous substance restrictions (RoHS regulations), and can withstand heat and temperature changes relatively well. And yet, the existing methods for synthesizing them

pose severe challenges.
The difficulty stems from a fundamental property of quantum dots: the bigger they are, the longer the wavelength they absorb. Reaching the SWIR regime (900-2,500 nanometers) therefore becomes experimentally challenging, as it requires considerably large quantum dots.
Some growth strategies rely on oleate ligands that bind uniformly across a nanoparticle's surface, producing spherical shapes as material is added at the same rate in every direction. These particles grow quickly and evenly, but only up to a point. Beyond a certain size, growth slows down, typically restricting the method's practical range to the near-infrared.
Other strategies use chloride and amine ligands, which accumulate selectively on four facets of the nanoparticle, producing a shape that resembles a tetrahedron. A quantum dot with this shape contains far less material than a spherical one of the same width, so, in principle, smaller CQDs could reach the SWIR regime. But this comes at a cost, because growing a large tetrahedron this way is slow, an obstacle typically bypassed by increasing the temperature over 300ºC and/or extending reaction times -both impractical for reaching th deep SWIR range

A novel methodology: grow fast first, shape second
ICFO researchers, **Dr. Taewan Kim**, **Dr. Jae Taek Oh**, **Hao Wu**, **Marta Martos Valverde**, and **Dr. Debranjan Mandal**, led by **ICREA Prof. Gerasimos Konstantatos**, have now overcome these limitations by combining the best of both worlds. **At first, spherical growth is promoted**, allowing the nanoparticle to grow large at moderate temperatures (260-280°C) in under a hour. Once sufficiently large,**the particle gradually shifts toward the more efficient tetrahedral shape**, ultimately absorbing SWIR wavelengths beyond 1,700 nanometers with **a volume nearly four times smaller than its spherical counterpart**.
The results, published in Advanced Materials, were achieved using amino-arsenic precursors and chloride ligands, which favor the tetrahedral shape, together with oleic acid and trioctylphosphine (TOP) ligands, which temporarily suppress that facet-selective binding early in the reaction.
ï¿½Our strategy induces a fast, spherical initial growth, but because chloride ligands rema n present, the pull toward tetrahedral facets never disappears, it's just delayed,ï¿½ explains Dr. Taewan Kim, first author of the article. ï¿½Eventually, the chloride wins out, and the shape drifts toward the tetrahedron,ï¿½
e adds. The method developed at ICFO offers additional benefits beyond those associa ed with reshaping. On one hand, the chosen precursors offer practical advantages in terms of both **safety** and **accessibility**. On the other hand, the employed ligands **improve the dots' processability into inks**, which significantly facilitates the fabrication of photodetectors.
In the end, the resulting devices showed **high optoelectronic performance and fast response speed** when detecting SWIR light, showcasing the promising potential of the strategy. The

study thus provides critical insights into how shape can overcome the intrinsic volumetric limits of CQDs, offering an alternative route for the industrial commercialization of SWIR photodetectors.

Reference:

T. Kim, J. T. Oh, H. Wu, M. M. Valverde, D. Mandal, and G. Konstantatos, ï¿½ Ligand-Mediat d Shape Engineering of SWIR InAs Colloidal Quantum Dots for Photodetector Applications.i ?½ Advanced Materials (2026): e74 04. DOI: https://doi.org/10.1002/adma.74004

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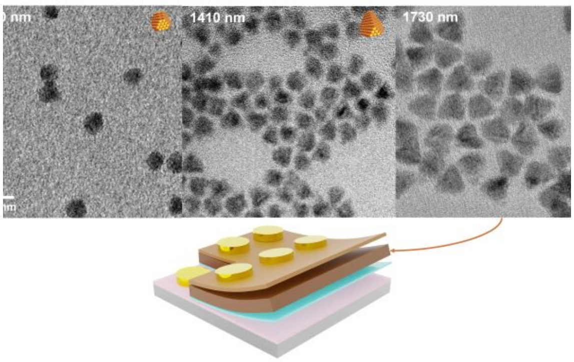

Top: TEM images showing a distinct morphological transition from spherical (?1200 nm) to faceted tetrahedral geometries (?1730 nm) as the particle size increases. Bottom: Schematic illustration of the device architecture employed for the InAs CQD photodet