

# Quantum dots offer an affordable alternative to infrared light sources

## Researchers at ICFO have developed a new source of shortwave infrared (SWIR) light based on quantum dots that is powerful, efficient, stable, and cost-effective. Reported in ACS Photonics, the approach overcomes the longstanding trade-off between high performance and affordability that has limited previous SWIR devices, opening the door to next-generation machine vision technologies. As a proof of concept, the team has already demonstrated its potential for industrial inspection, food safety monitoring, surveillance, and biomedical diagnostics.

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Imaging through smoke and fog, at night, from a remote location, keeping the eyes safe... These desirable features for next-generation machine vision technologies could all be enabled by **shortwave infrared (SWIR) light**. However, conventional SWIR-emitting technologies face significant challenges and do not yet offer a viable alternative that simultaneously achieves high power, high efficiency, and low cost.

For the past few years, the Functional Optoelectronic Nanomaterials group at ICFO has been looking for cost-effective alternatives based on quantum dots -tiny semiconductors that behave like individual atoms- that don't sacrifice efficiency. In a recent publication in ACS Photonics, **Aditya Jagadeesh Malla**, **Dr. Katerina Nikolaidou**, **Miguel Dosil**, **Dr. Mariona Dalmases**, **Dr. Stephy Vincent**, and **Marta Martos Valverde**, led by **ICREA Prof. Gerasimos Konstantatos**, have demonstrated that **lead sulfide quantum dots can indeed give rise to high-power, efficient, and stable downconverters** (devices that absorb higher-frequency photons and convert them to lower-frequency ones, in this case, within the SWIR range).

To achieve their goal, the researchers took advantage of a defining property of quantum dots, namely, that the larger the dots, the lower the frequency of the photons they emit and absorb. Thus, the team employed smaller dots to absorb high-frequency light and mixed them with bigger ones that emitted in the SWIR range. By simply varying the size of the emitting dots, they could cover a significant part of the SWIR region, creating a **highly tunable downconverter**.

The team, however, had to face the quantum dots main drawback: significant heat generation after light absorption. Overcoming this limitation required an innovative device architecture. i¿½We dispersed the quantum dots in a polymer that was then sandwich d between two different substrates (a DBR and a sapphire substrate),i¿½ explains first au hor Aditya Jagadeesh. The result was an **emission power density** of 385 mW/cm2 at a SWIR wavelength of 1380 nm, a significant milestone that sets a new record for infrared quantum dot light emitters. Aditya puts it in perspective: i¿½At the moment, there are only a few pric y SWIR light sources available. Our study, conversely, demonstrates that high-power output s possible at an affordable cost.i

?½ Several applications could benefit from these novel devices. In the study, the researc ers already showcased their potential for night vision and vision under adverse wea her conditions for **automotive use or fire-fighting**, seeing through certain plastics and silicon wafers for **industrial quality control**, eye-safe imaging for **facial recognition**, moisture detection for **agriculture and the food industry**, and under-tissue visualization for **biomedical imaging**.

i¿½With the arrival of low-cost SWIR image sensors based on colloidal quantum dots, e anticipated that the next thing to address was the supply of a low-cost light source that c n be manufactured at scalei¿½ says Prof. Gerasimos Konstantatos, lead researcher of the st dy. i¿½With this worki¿½, he adds, i¿½we are confident that colloidal quantum dot can also bridge the gap between affordability and performance in SWIR sourc

**Reference:**

Aditya Jagadeesh Malla, Katerina Nikolaidou, Miguel Dosil, Mariona Dalmases, Stephy Vincent, Marta Martos Valverde, and Gerasimos Konstantatos, High Power, Efficient, and Stable Quantum Dot-Based Downconverters for SWIR Applications, ACS Photonics **2026** 13

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