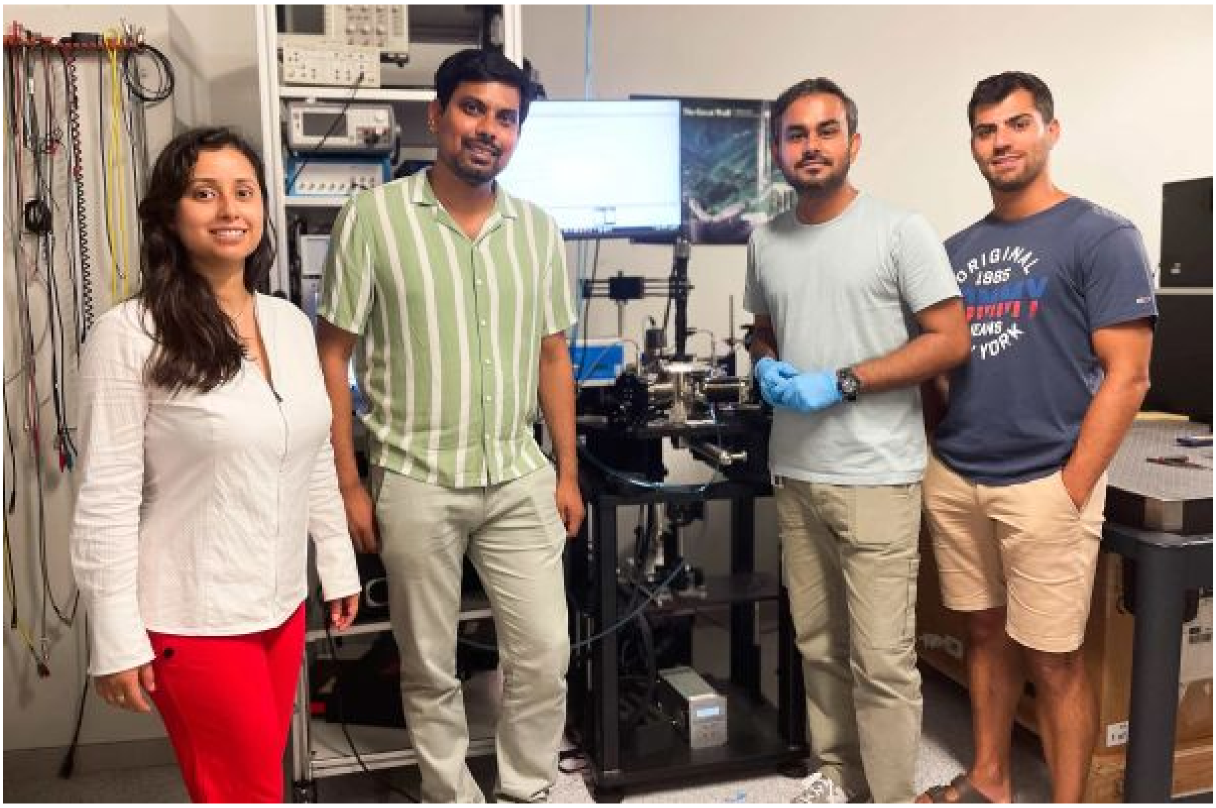


Colloidal quantum dots: a scalable path to infrared detection

ICFO researchers have developed a bolometer based on colloidal quantum dots (CQDs) to detect infrared light at room temperature. The novel bolometer utilizes a CQDs-based thermal resistor (thermistor) that has higher sensitivity than other state-of-the-art platforms and, at the same time, is low in cost, compatible with CMOS technology, and is free from the need to match crystal structures during fabrication. The technology, published in Advanced Materials, could dramatically lower production costs and unlock high-volume commercial markets.

June 29, 2026

The ability to detect mid- and long-wave infrared (MWIR and LWIR) light at room temperature could unlock applications in non-invasive medical diagnosis, environmental monitoring, or the autonomous vehicle industry. For example, such detectors would be ideal for identifying pedestrians, wildlife, or hazards well beyond the reach of standard headlights in inclement weather. Promising candidates for developing them are the so-called **bolometers,** instruments that measure how much electromagnetic radiation is emitted by an object. Specifically, when a photon is absorbed, the bolometer's temperature increases and, as a result, its electrical resistance changes; this variation in resistance indicates that photons have been detected.

The **temperature coefficient of resistance** (TCR) describes how much the bolometer's resistance varies with temperature. High TCR values are needed to unmistakably identify that a photon has truly been absorbed; otherwise, photon absorption might be lost in noise and go unnoticed. Single-crystalline semiconductors, like SiGe/Si quantum wells, show the highest TCRs to date, but the methods used for growing them (epitaxial processes) require bulky and energy-expensive cryogenic cooling systems, and they give rise to defects that inherently prevent the sensors from achieving even higher TCR values.

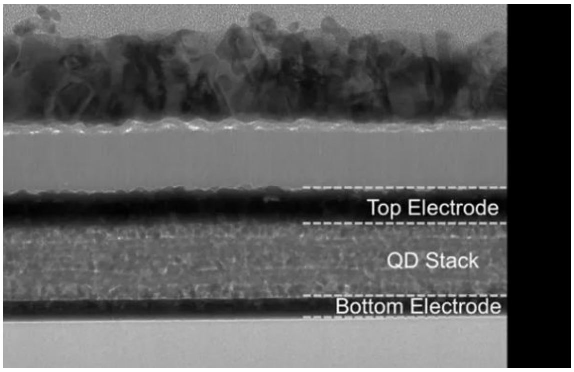
ICFO researchers, **Dr. Gaurav Kumar**, **Dr. Mariona Dalmases**, **Dr. Nima Taghipour**, **Dr. Rajesh Bera**, **Dr. Guy L. Whitworth**, **Goretti Torres Perez**, and **Miguel Dosil**, led by **ICREA Prof. Gerasimos Konstantatos**, have now developed **a novel bolometer based on colloidal quantum dots (CQDs)** that circumvents traditional limitations. Presented in Advanced Materials, the platform, when integrated with a plasmonic metamaterial absorber, can **detect photons within the MWIR/LWIR range at room temperature**, achieving **a record TCR value** (9.1 %/K). The bolometer was built by alternately stacking CQDs of different sizes **processed as a solution**, avoiding cryogenic cooling and defects introduced by epitaxial growth. Thanks to this arrangement, the minimum thermal energy that activates the bolometer can be modulated, which is crucial for achieving high TCR values and efficiently detecting infrared photons. ï¿½Our study proves that the structural constraints of rigid, expensive crystals a d power-consuming techniques can be entirely bypassed by using simpl , solution-processable nanotechnologies,ï¿½ says Dr. Gaurav Kumar, first author of the arti le. Overall, these bolometers exhibit higher TCR values than traditional approaches, with the added advantages that colloidal quantum dots entail; namely, **solution-processability, low cost, and compatibility with CMOS technology** (the main technology used for constructing integrated circuit chips). ï¿½Colloidal quantum dots could bring down the cost of infrar d detectors, allowing for wider dissemination and greater penetration into civilian sectors,ï ?½ claims ICREA Prof. Gerasimos Konstantatos, long-time expert in quantum dots and ead researcher of the study. As such, the study lays the foundation for a new type of mate ial platform that could significantly advance room-temperature infrared sens

Reference:

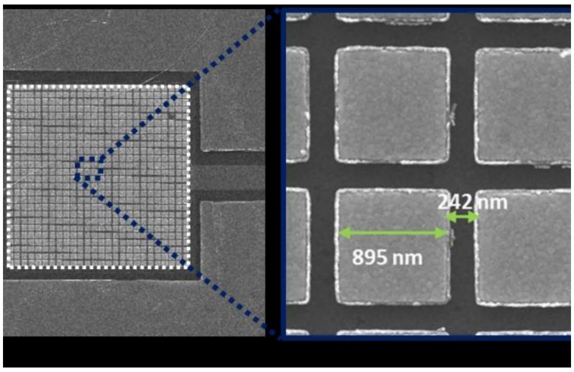
G.Kumar, M.Dalmases, N.Taghipour, et al. ï¿½A Colloidal Quantum Dot Thermistor a d Bolometer.ï¿½ Advanced Materials (2026): e19 85. DOI: https://doi.org/10.1002/adma.202519385

Acknowledgements:

G.K. acknowledges financial support from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 101002306), the Fundacio Privada Cellex, the program CERCA and ï¿½Severo Ochoai ?½ Centre of Excellence CEX2019-000910-S funded by the Spanish State Research Agency. R.B acknowledges the Marie Sklodowska-Curie grant agreement No. 101151468 for funding a d a fellowship. G.T.P acknowledges support from ï¿½la Caixaiï¿½ foundation (ID 10 010434) through fellowship LCF/BF/DI22/11940035. We are also thankful to Dr. Sukeert to measure the QCL beam spot size and to Marta Martos Valverde for helping in high-resolu ion SEM characterization.



High-resolution transmission electron microscopy (HR-TEM) image of the cross-section of the quantum dot potential-barrier thermistor (QDPBT) structure. The QDPBT layer is visibly made up of layers with large QDs and small QDs. Source: Advanced



SEM images of the QDPBT pixel with the plasmonic metamaterial absorber (PMA) pattern and the Au window surrounding it (left), and a magnified view of the PMA pattern (right). Source: Advanced Materials.

At the front, Gaurav Kumar working with the experimental setup, at the back, Rajesh Bera, Miguel Dosil, and Goretti Torres Perez. Credit: ICFO.