3D nanoprinting using semiconductor quantum dots to create optoelectrical materials

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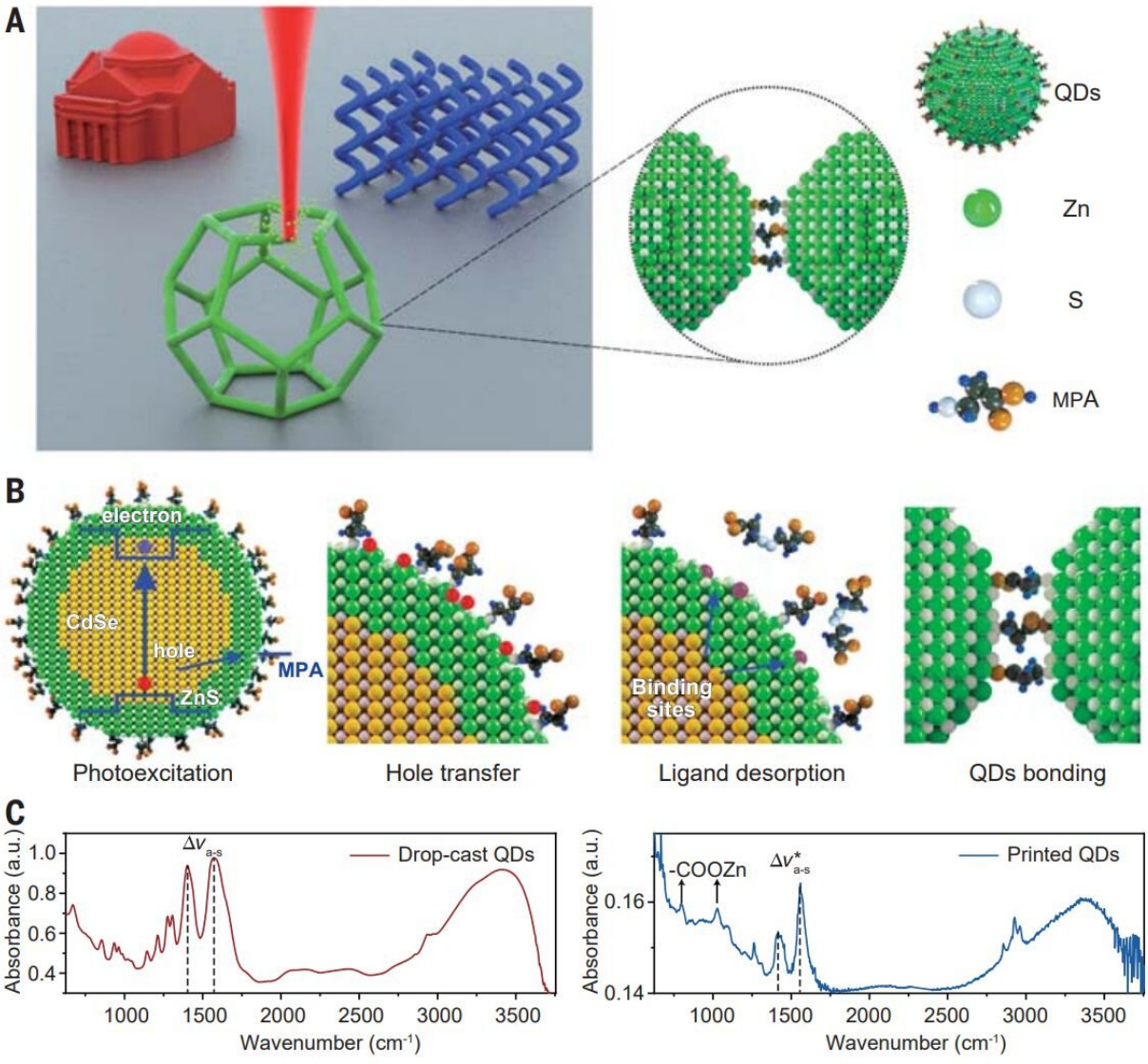

Working principle of PEB. (A) Schematic illustration showing 3D nanoprinting of MPA-capped CdSe/ZnS QDs using PEB. (B) Schematic illustration showing the underlying mechanism of PEB. (C) FTIR spectra of the drop-cast QDs and printed structure. Credit: *Science* (2022). DOI: 10.1126/science.abo5345

A team of researchers from Tsinghua University, working with a colleague from Jilin University, has developed a new 3D nanoprinting technique that uses semiconducting quantum dots. In their paper published in the journal *Science*, the group describes their new technique and provides examples of resulting 3D objects. Jia-Ahn Pan and Dmitri Talapin with the University of Chicago provide a Perspective piece in the same journal issue regarding more versatile 3D printing devices and the work done by the team on this new effort.

The use of 3D printing to make three-dimensional objects has expanded greatly over the past decade, leading to new products and faster ways to create demonstration objects. But, as the researchers with this new effort note, 3D printers primarily use materials based on polymers, limiting the type of products that can be made. Manufacturers say they would buy 3D printers capable of printing products with optical or electronic properties. In this new effort, the researchers in China have taken a big step in that direction.

The new method involves using semiconductor quantum dots (nanocrystals made of cadmium selenide, covered with zinc sulfide and with caps made of 3-mercaptopropionic acid ligands) as additions to printing material. The dots are activated using a laser. Photons from the laser are absorbed by a nanocrystal, resulting in a change in chemistry that allows for bonding between the quantum dots—a process known as two-photon absorption. In their setup, absorption of the protons was only possible in places where the light intensity was at its highest. This

allowed for creating bonds smaller than the wavelength of the light.

The researchers note that their technique preserves the optoelectronic properties of the quantum dots, which means that 3D products that are printed using the ink made with them can be used in optoelectronic devices.

The researchers demonstrated the soundness of their ideas by building a 3D printer capable of performing two-photon absorption and then used it to create several objects, some of which were light-emitting university badges. They also demonstrated that it could be used with a variety of materials.

More information: Shao-Feng Liu et al, 3D nanoprinting of semiconductor quantum dots by photoexcitation-induced chemical bonding, *Science* (2022). DOI: 10.1126/science.abo5345

Jia-Ahn Pan et al, 3D-printing nanocrystals with light, *Science* (2022). DOI: 10.1126/science.add8382