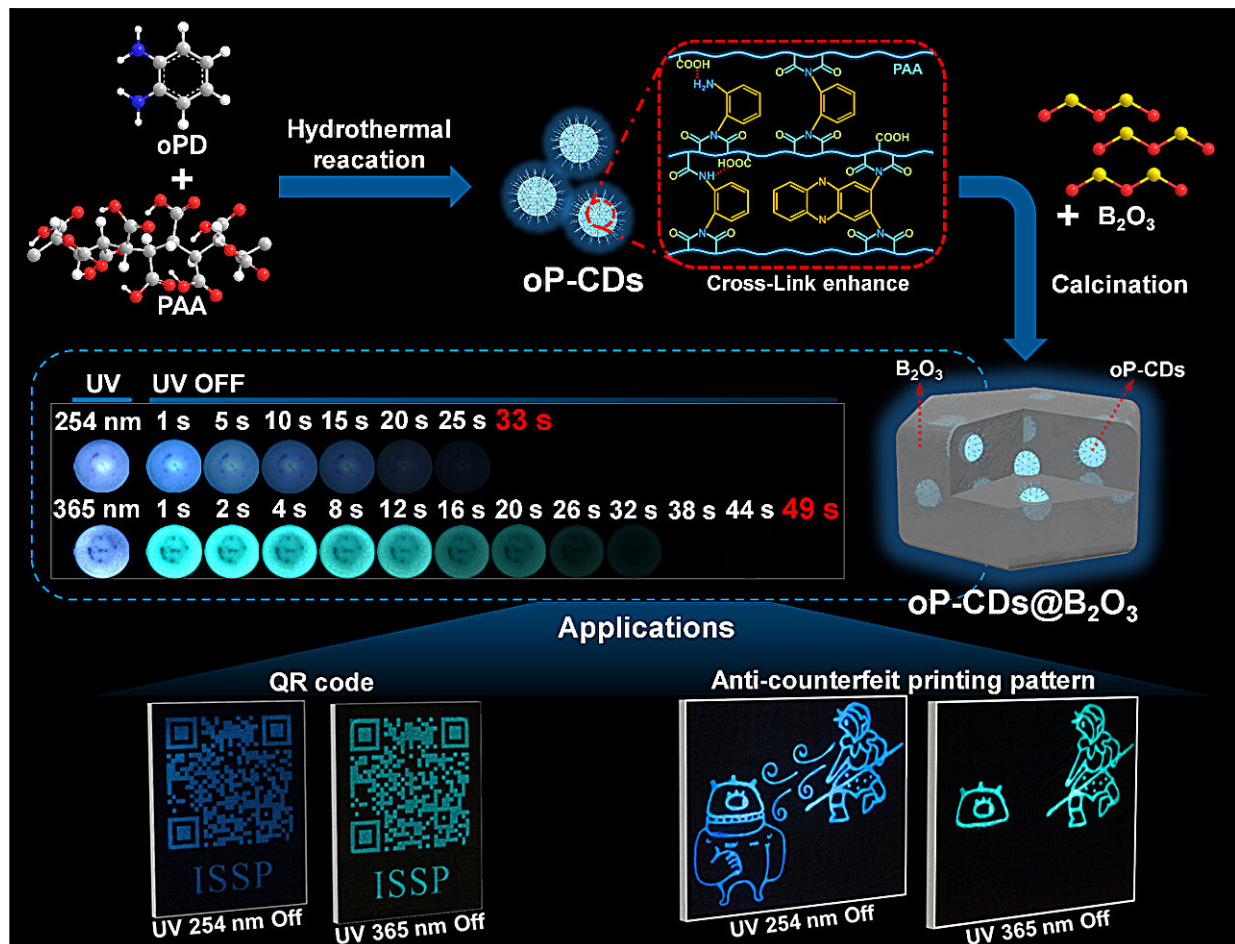


Novel method developed for phosphorescent multi-color carbon dots

April 16 2024, by Zhang Qipeng, Yang Liang, Zhao Weiwei



Schematic diagram of the preparation of multi-color long-lived room-temperature phosphorescent composite materials based on carbon dots and their potential applications in anti-counterfeiting. Credit: ZHANG Qipeng

A research team has devised a novel method to prepare carbonized polymer nanodots capable of emitting multi-color ultra-long room-temperature phosphorescence (RTP) from blue to green.

"These materials exhibit potential applications in anti-counterfeiting and information encryption," said Zhang Qipeng, member of the team.

The research findings have been [published](#) in *Advanced Science*, and the study was led by Jiang Changlong from Hefei Institutes of Physical Science of Chinese Academy of Sciences

RTP materials glow even after the [light source](#) is removed, making them valuable for various uses like [security features](#), [data protection](#), displays, and medical imaging. Carbon dots (CDs) are a kind of RTP material known for being easy to make, stable under light, and safe. But making bright and long-lasting RTP materials with CDs is tough due to non-radiative loss of energy.

Also, it's hard to get different phosphorescent colors from single carbon dots materials, limiting their use. Therefore, the development of multi-color, long-lived, and high quantum yield RTP carbon dots materials is imperative.

The method developed in this research is to synthesize carbonized [polymer](#) nanodots using ortho-phenylenediamine (oPD) and polyacrylic acid (PAA) hydrothermal synthesis. Researchers mixed some chemicals called ortho-phenylenediamine (oPD) and polyacrylic acid (PAA) together in hot water to make these dots. Then, they baked these dots with boron oxide (B_2O_3) to make them glow for a long time, from blue to green.

Adding oPD made these CDs glow in different phosphorescent colors because of the doping of nitrogen element. PAA, which is a long chain

of molecules, made these CDs act like other carbonized polymer nanodots made from polymers. The long-chain cross-linking structures of these polymers fix the luminescent groups inside carbonized polymer dots through [covalent bonds](#) and hydrogen bonds, reducing non-radiative losses and thereby enhancing the phosphorescence of CDs.

The boron oxide, which is like a hard shell around the CDs, also helped keep the phosphorescent energy from non-radiative losses. The synergistic effect of cross-linked polymer structures inside carbon dots and their rigid shells enables these [carbon dots](#) to exhibit excellent phosphorescence, with a visible duration of up to 49 seconds and a maximum phosphorescence quantum yield of 19.5%.

They also demonstrate remarkable resistance to photobleaching. As a result, these carbon dot materials hold great promise for applications in anti-counterfeiting and information encryption.

This research not only improves our understanding of RTP materials but also paves the way for creating versatile and high-performance materials for security and data protection, according to the team.

More information: Qipeng Zhang et al, Multiemitting Ultralong Phosphorescent Carbonized Polymer Dots via Synergistic Enhancement Structure Design, *Advanced Science* (2024). [DOI: 10.1002/advs.202400781](#)

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