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Researchers develop high-efficiency afterglow material

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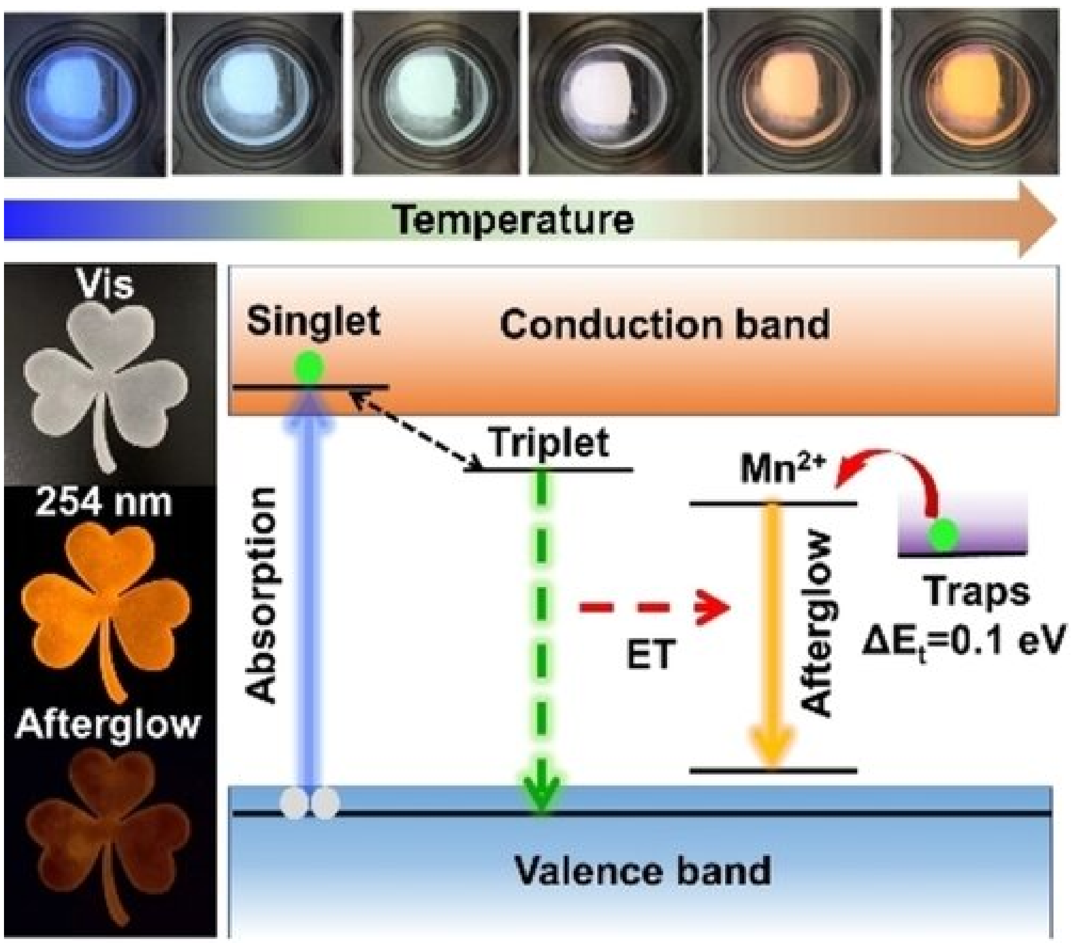

Graphical abstract. Credit: *Angewandte Chemie International Edition* (2022). DOI: 10.1002/anie.202210975

A research group led by Dr. Yang Bin from the Dalian Institute of

Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has developed cadmium (Cd)-based perovskite single crystals with long afterglow and high luminous quantum yield, and investigated its afterglow luminescence dynamics mechanism.

The study was published in *Angewandte Chemie International Edition* on Oct. 21.

Afterglow materials have the ability to store multiple radiations such as visible photons, ultraviolet rays, and X-rays. They are widely used in display, biological imaging, anti-counterfeiting technology, and data storage.

However, traditional all-inorganic phosphors, such as oxide, sulfide, and nitride-based afterglow materials, have high lattice energy and usually need to be produced by high-temperature processing (>1000°C), which brings considerable energy consumption and safety risks to production and preparation.

Using solution-processed perovskite $CsCdCl_3$ single crystal as the afterglow matrix, the researchers proposed a luminescence strategy based on energy transfer from triplet self-trapped excitons (STE) to the acceptor Mn^+ through Mn^{2+} doping. They developed a high-efficiency ultra-long anti-thermal quenching afterglow emitting phosphor, which could simultaneously achieve high luminescence quantum yield (81.5%) and ultra-long afterglow time (150 seconds).

Moreover, they provided clear evidence for the luminescence mechanism through in-depth carrier dynamics studies and density functional theory (DFT) calculations. They found that the $CsCdCl_3Mn^{2+}$ structure had $[CdCl_6]^{4-}$ octahedron with plane symmetry (C_{3v} symmetry) and angular symmetry (D_{3d} symmetry) nature, which could form inequivalent Cl vacancies, and result in trap states with a broad energy distribution.

"We found that these trap states can store charge carriers and slowly release them to the emission center ($[MnCl_6]^{4-}$ octahedron), resulting in afterglow emission with anti-thermal quenching effect," said Dr. Yang.

More information: Zhe Tang et al, Highly Efficient and Ultralong Afterglow Emission with Anti-Thermal Quenching from $CsCdCl_3$: Mn Perovskite Single Crystals, *Angewandte Chemie International Edition* (2022). DOI: 10.1002/anie.202210975

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