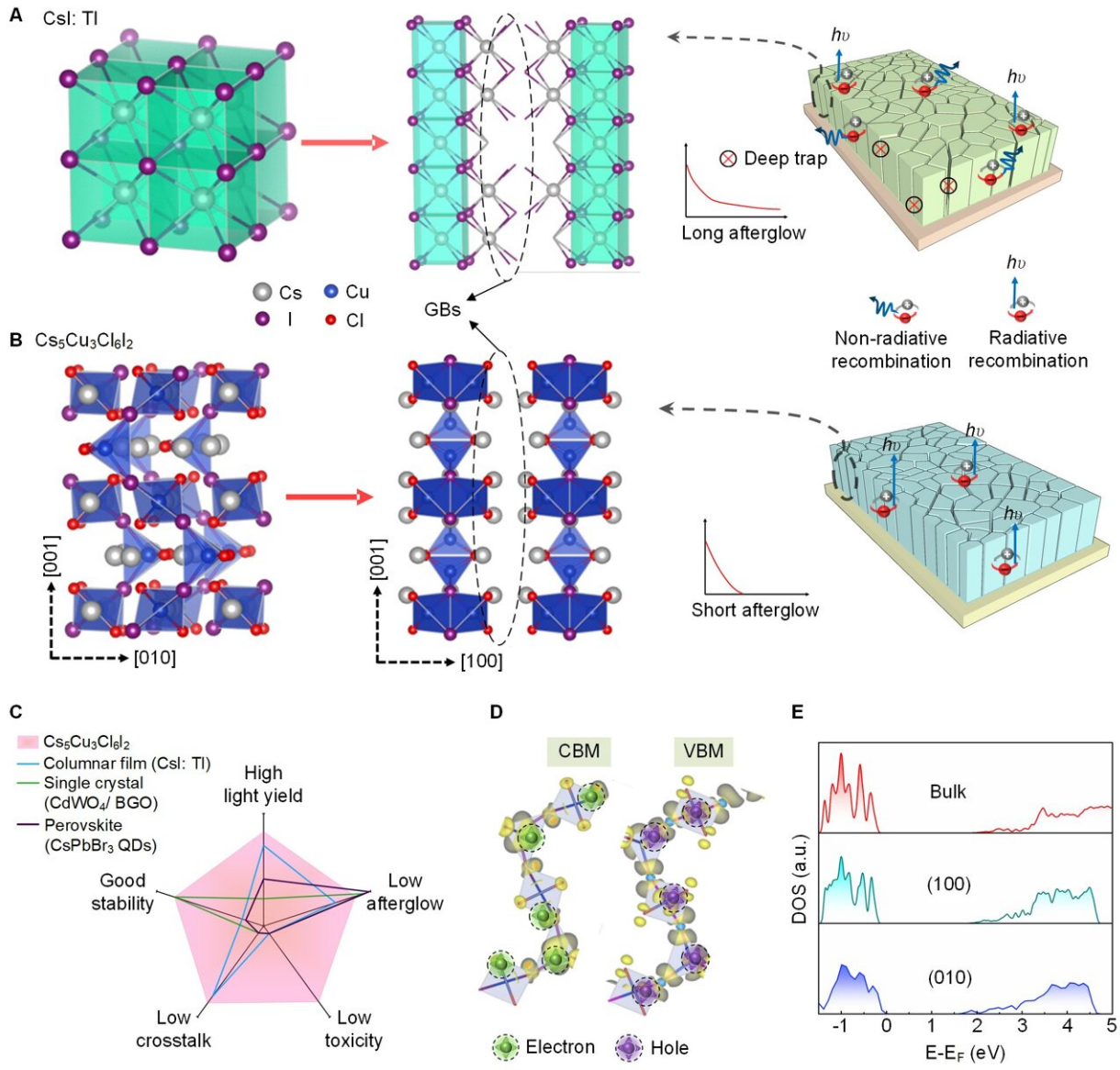
New scintillator film with benign grain boundaries developed for high-resolution, fast X-ray imaging

July 31 2023, by Zhang Nannan



Comparison between traditional 3D CsI:Tl scintillating film and 1D perovskite $Cs_5Cu_3Cl_6I_2$ scintillating film. Credit: Wu Haodi

A research team led by Prof. Wu Yuntao from the Shanghai Institute of Ceramics of the Chinese Academy of Sciences, together with collaborators from Huazhong University of Science and Technology, has developed a new type of inorganic scintillator for high-resolution, fast X-ray imaging. The study was published in *Science Advances*.

Scintillators are essential in X-ray detectors for small spot detection and high-speed imaging. Columnar structured scintillator films, such as CsI:Tl, enjoy low scattering and inter-pixel crosstalk and have demonstrated their intrinsic advantages in high-resolution and high-pixel fill factor for X-ray flat panel detectors. However, the afterglow effect, which causes residual shadow and blurred images, remains a serious challenge for scintillator films.

In this study, the researchers developed a one-dimensional (1D) $Cs_5Cu_3Cl_6I_2$ scintillator, in which the carriers are mostly confined within the 1D chains, whose atoms are connected by strong covalent bonds. The 1D $Cs_5Cu_3Cl_6I_2$ films tend to grow into columnar structures, thermodynamically driven by the faster growth rate along the chains.

Crucially, these films preserve chain integrity at grain boundaries, eliminating detrimental dangling bonds and reducing nonradiative recombination losses and afterglow, thus making them very suitable for scintillator films used in high-resolution and fast imaging.

The rationally designed 1D scintillator $Cs_5Cu_3Cl_6I_2$ exhibits the long-sought combination of high scintillation yield (1.2 times that of CsI:Tl),

low afterglow (0.1% at 10 ms), columnar growth capability, low toxicity, and good stability.

According to the researchers, the $Cs_5Cu_3Cl_6I_2$ X-ray imager achieved high spatial resolution and excellent detective quantum efficiency, surpassing almost all reported scintillators.

In addition, it has high stability against humidity and continuous irradiation, and its component elements are inexpensive, nontoxic and nonradioactive.

This new material represents a significant breakthrough in the performance and cost of scintillators, opening up new possibilities for fast, high resolution X-ray imaging applications.

More information: Haodi Wu et al, One-dimensional scintillator film with benign grain boundaries for high-resolution and fast x-ray imaging, *Science Advances* (2023). DOI: 10.1126/sciadv.adh1789

Provided by Chinese Academy of Sciences