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Credit: Amei Ott/EyeEm

PEROVSKITES

Super scintillators

Scintillators — materials that absorb ionizing radiation and luminesce — are used to detect radiation and have applications in fields such as medical diagnostics and security screening. However, the applicability of most scintillators, typically bulk materials, is limited by the requirement for high-temperature (>1,000 °C) solid-state synthesis and their non-tuneable emission. Now, reporting in *Nature*, Huanghao Yang, Wei Huang, Xiaogang Liu and colleagues introduce a class of solution-processable and tuneable scintillators based on all-inorganic perovskite nanocrystals. These materials enable the fabrication of highly sensitive X-ray detectors.

The team inject a hot solution of Cs-oleate into a solution of PbX_2 (X = Cl, Br, I) at 160 °C to prepare $CsPbX_3$ nanocrystals. Upon X-ray irradiation, these nanocrystals show narrow and tuneable emission at visible wavelengths. The colour of the emission can be readily controlled by tailoring the bandgap of the nanocrystals through variation of the halide composition, offering the possibility of multicolour X-ray scintillation. Moreover, the sensitivity of the perovskite nanocrystals to X-rays is comparable or superior to commercial bulk scintillators, such as CsI:Tl and $YAlO_3$:Ce, which the authors attribute to the strong X-ray stopping power and high light conversion yields of the perovskites.

$CsPbBr_3$ nanocrystals can be spin coated onto a polydimethylsiloxane substrate to produce a thin-film device for the conversion of X-ray radiation into visible light. This device has a very fast response to X-ray illumination and a detection limit of 13 nanograys per second — ~400 times lower than the typical X-ray dosage in medical diagnostics. This fast response and high sensitivity are desirable for medical applications, and, as Liu explains, “the use of such X-ray detectors enables X-ray images to be taken with low X-ray doses and thus could substantially reduce the exposure risk to patients.”

As a proof-of-concept, the team constructed a flat-panel X-ray detector comprising a $CsPbBr_3$ nanocrystal scintillator layer on top of an amorphous Si photodiode array. Compared with a commercial CsI:Tl-based flat-panel X-ray detector, the perovskite detector achieves a higher spatial resolution and much faster X-ray response, making it attractive for real-time imaging. Indeed, it is possible to visualize the internal structure of electronic circuits and smartphones using the prototype detector.

Solution-processable scintillators are key to fabricating large-area, low-cost thin-film X-ray detectors. “Solution processing could make it easier to integrate X-ray detectors into devices and speed up their introduction to the market,” adds Huang. Commercialization is, however, currently hampered by the instability issues associated with perovskites. Nevertheless, the authors are optimistic: “these drawbacks can be overcome, or avoided in the case of X-ray detectors, by the proper use of packaging materials to protect against moisture and excessive light or heat exposure,” explains Yang. Certainly, the team are excited about future possibilities and plan to develop portable flexible devices for medical and industrial imaging. “The community has been longing for a new type of scintillator that combines high X-ray stopping power and scintillation efficiency and is suitable for scalable production and integration into flexible devices. I believe that we have found one,” concludes Liu.

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ORIGINAL ARTICLE Chen, Q. et al. All-inorganic perovskite nanocrystal scintillators. *Nature* **561**, 88–93 (2018)