Dong and Fang *Light: Science & Applications* (2023)12:8
https://doi.org/10.1038/s41377-022-01060-8

Official journal of the CIOMP 2047-7538
www.nature.com/lsa

NEWS & VIEWS

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Metal-halide perovskites for high-efficiency radiation shielding applications

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Abstract

The ionizing radiation possesses extremely strong penetration capability, which poses serious risk on the health of the human body and jeopardize electronics. Here the authors demonstrate that $MAPbI_3$/epoxy composites prepared by a simple method show high radiation shielding performance.

The ionizing radiation, including X-ray and gamma-ray, possesses extremely strong penetration capability, which poses serious risk on the health of the human body due to its damage to deoxyribonucleic acid that would profoundly increase the probability of developing cancer diseases[1,2]. Meanwhile, the ionizing radiation could also jeopardize the efficacy and stability of electronic devices when operated in the environment with high-dose radiation exposure, like in the space or nuclear plants[3–5]. Therefore, the high-performance radiation shielding materials are urgently required to alleviate the radiation risks.

The key parameter that determines the attenuation power of radiation shielding materials is their linear attenuation coefficients, which is correlated with the atomic number of the active materials[6,7]. Consequently, materials with large atomic number, such as lead, concretes, tungsten, etc., have been widely adopted for the shielding of ionizing radiation[8,9]. Nevertheless, in some application scenarios like in space environment or medical diagnosis, the radiation shielding materials with both large linear attenuation coefficient and small density are more favorable since the portability and flexibility of the radiation protection can be greatly enhanced[10]. Recently, metal halide perovskites (MHPs) have gained increasing research attention as the next-generation radiation detection materials due to their low-cost solution processibility, excellent charge transport properties, as well as strong radiation-stopping power[11–14]. In view of the large atomic number and the resultant high mass attenuation coefficient, the MHPs can potentially also function as the radiation shielding materials, which, however, has seldom been explored.

A recent publication in *Light: Advanced Manufacturing* by Cui et al. provide a new insight into the engineering application of classic MHPs as high-performance radiation shielding materials[15]. They prepared $MAPbI_3$/epoxy composites by a simple method with high radiation shielding performance against 59.5 keV gamma ray (Fig. 1a, b). High linear attenuation coefficient (1.887 cm^{-1}) and mass attenuation coefficient (1.352 cm^2/g) achieved in prepared $MAPbI_3$/epoxy composites, which show better gamma ray (59.5 keV) shielding ability in terms of the larger μ and μ_m than the most commonly used shielding materials (Fig. 1c).

Despite the high linear attenuation coefficient and mass attenuation coefficient achieved in the $MAPbI_3$/epoxy composite, more works remains to be done in the future to promote its practical application as the radiation shielding materials. For instance, the long-term stability of the $MAPbI_3$/epoxy composite, including the moisture, irradiation, and temperature stability, needs to be evaluated to accommodate the harsh environments. Besides, future attempts can be done to replace $MAPbI_3$ with lead-free MHPs for reduced environmental toxicity. Nevertheless, the presented

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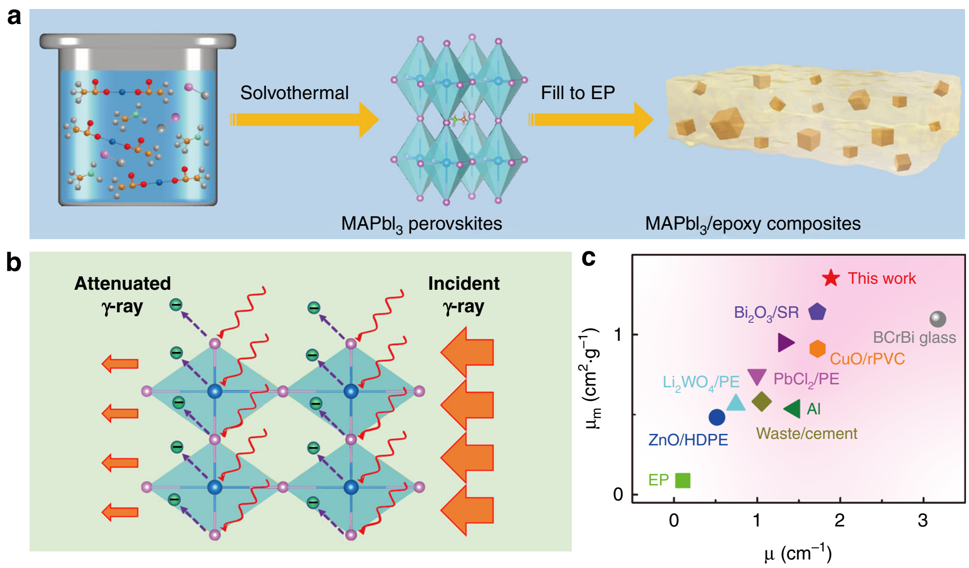

Fig. 1 $MAPbI_3$/epoxy based radiation shielding materials. a Schematic illustration of the $MAPbI_3$ microcubic crystals and the $MAPbI_3$/epoxy composites; **b** Schematic illustration of gamma ray shielding of the $MAPbI_3$/epoxy composites; **c** μ and μ_m of some commonly used materials reported in recent years.

work demonstrated the bright future of MHPs/epoxy composite as the next-generation high-performance yet low-cost radiation shielding materials.

Published online: 02 January 2023

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