Researchers develop perovskite X-ray detector for medical imaging

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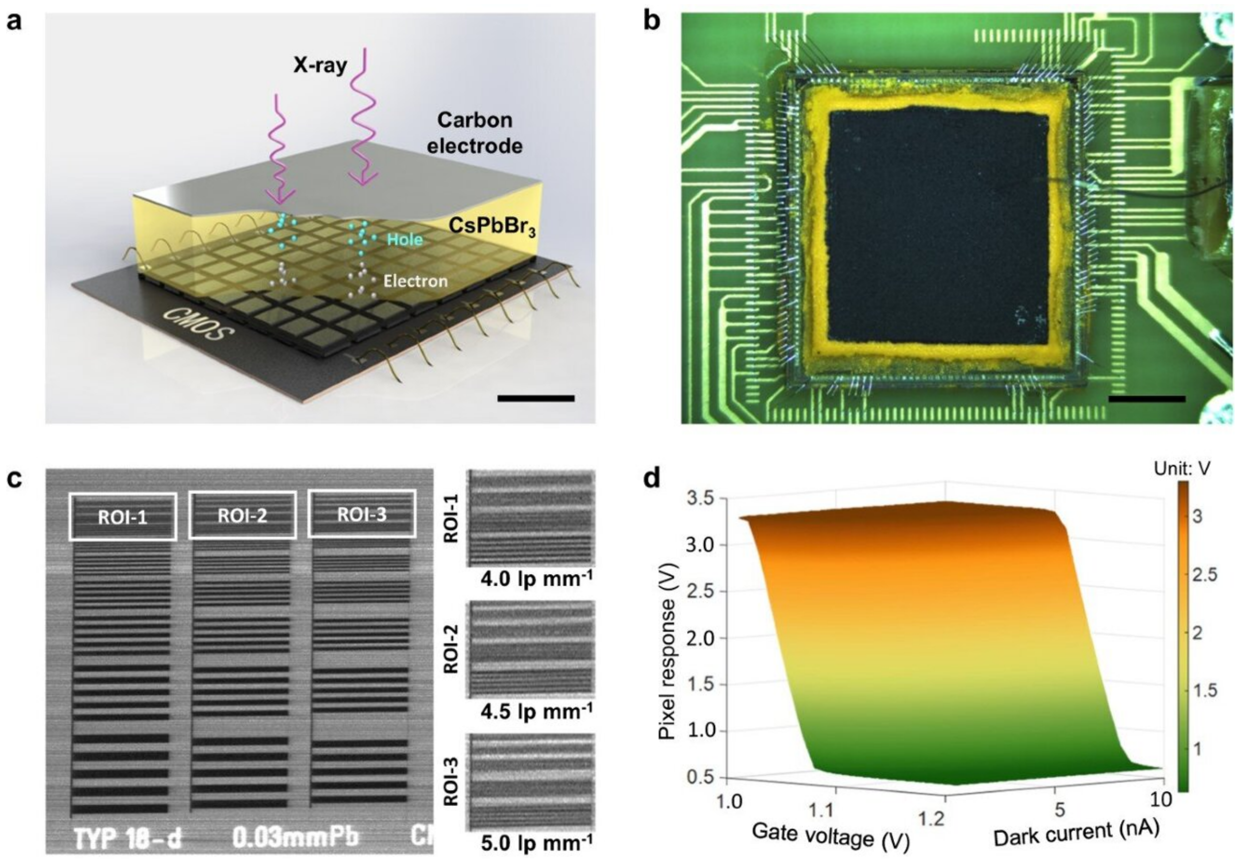

Inorganic CsPbBr3 based direct-conversion X-ray CMOS detector. Credit: SIAT / Yongshuai Ge

Shenzhen Institutes of Advanced Technology (SIAT) of the Chinese Academy of Sciences, in collaboration with researchers at Central China

Normal University, have developed a high-performance perovskite X-ray complementary metal-oxide-semiconductor (CMOS) detector for medical imaging.

The study was published in *Nature Communications* on Feb. 21.

X-ray imaging is vital for the diagnosis and treatment of cardiovascular and cancer diseases. Direct-conversion X-ray detectors made of semiconductor materials exhibit superior spatial and temporal resolution at lower radiation doses compared to indirect-conversion detectors made of scintillator materials. However, the currently available semiconductor materials, such as Si, a-Se, and CdZnTe/CdTe, are not ideal for general X-ray imaging due to their low X-ray absorption efficiency or high costs.

Perovskite is a promising alternative to conventional semiconductor materials. However, the feasibility of its combination with high-speed pixelated CMOS arrays is still unknown.

To address this issue, researchers developed a direct-conversion X-ray detector fabricated with a 300 μm thick inorganic $CsPbBr_3$ perovskite film printed on a dedicated CMOS pixel array.

Researchers found that the screen-printed thick $CsPbBr_3$ film has a high $\mu\tau$ product of 5.2×10^{-4} cm^2 V^{-1}, a high X-ray detection sensitivity of 15,891 μC Gy_{air}^{-1} cm^{-2}, and a low dose detection limit of 321 nGy_{air} s^{-1}.

Experimental X-ray 2D imaging results showed that the proposed perovskite CMOS detector can achieve very high spatial resolution (5.0 lp mm^{-1}, hardware limit is 6.0 lp mm^{-1}) and low-dose (260 nGy) imaging performance.

Moreover, 3D CT imaging was also validated with the proposed detector at a fast signal readout speed of 300 fps.

"Our work shows the potential of lead halide perovskites in revolutionizing the development of state-of-the-art X-ray detectors with significantly enhanced spatial resolution, readout speed, and low-dose detection efficiency," said Prof. Ge.

"This paves the road for medical X-ray imaging applications to become gentler and safer in the future."

More information: Yanliang Liu et al, Dynamic X-ray imaging with screen-printed perovskite CMOS array, *Nature Communications* (2024). DOI: 10.1038/s41467-024-45871-2

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