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***In situ* growth of epitaxial lead iodide films composed of hexagonal single crystals**

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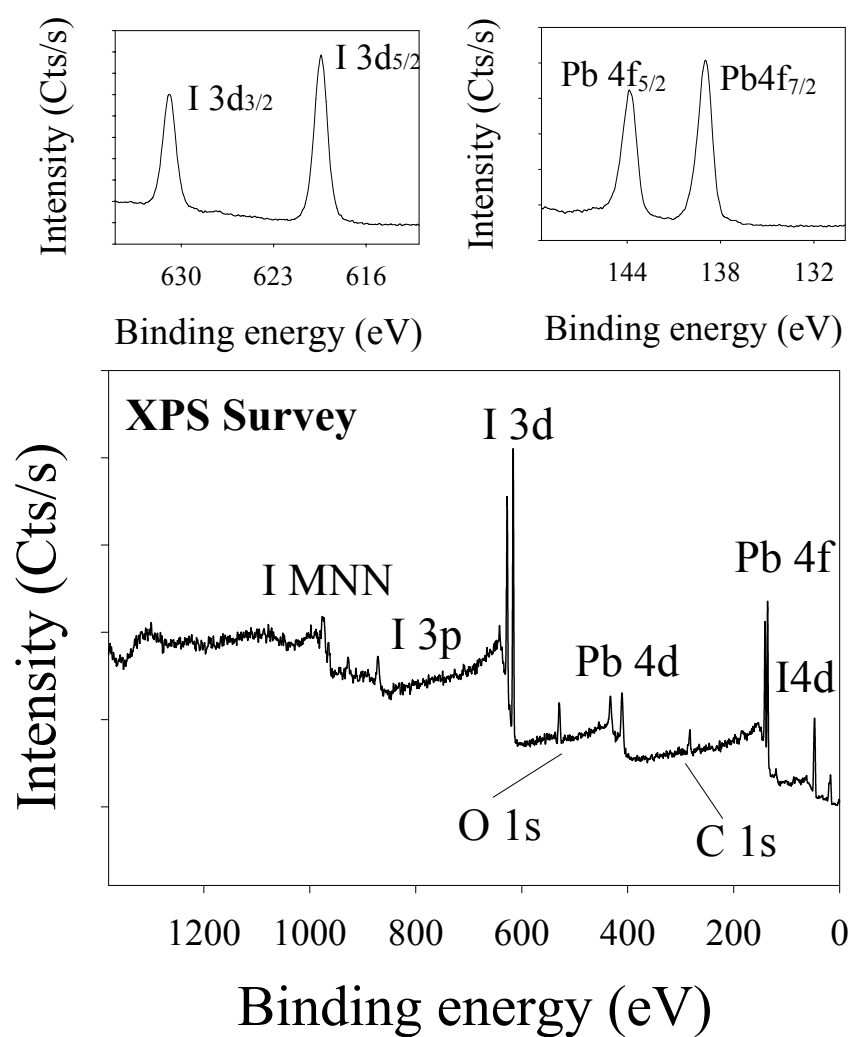
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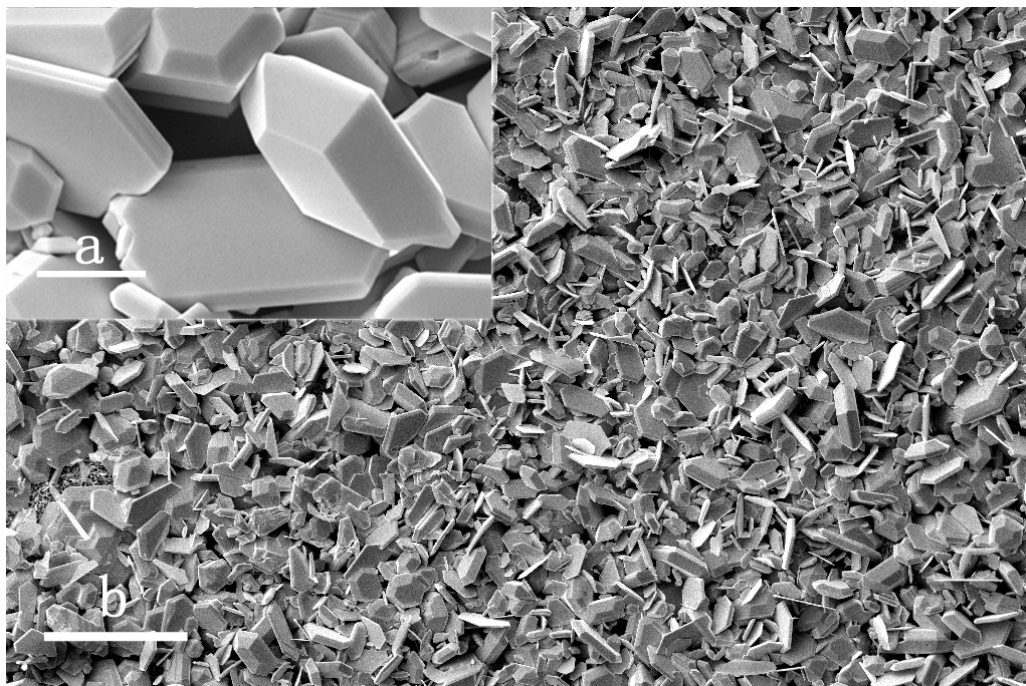
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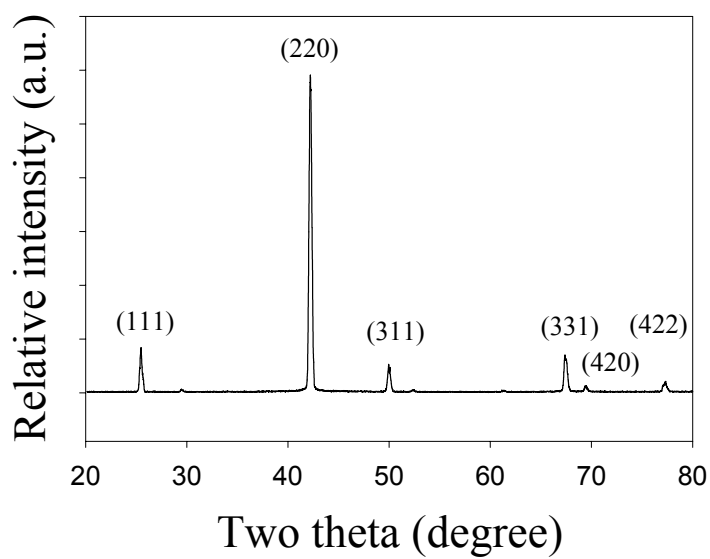
**Figure S1.** XPS I 3d, Pb 4f core level spectra and survey spectrum of  $\text{PbI}_2$  crystals/films generated from  $\text{I}_2$ /ethanol system with the iodine concentration of 0.007g/ml.



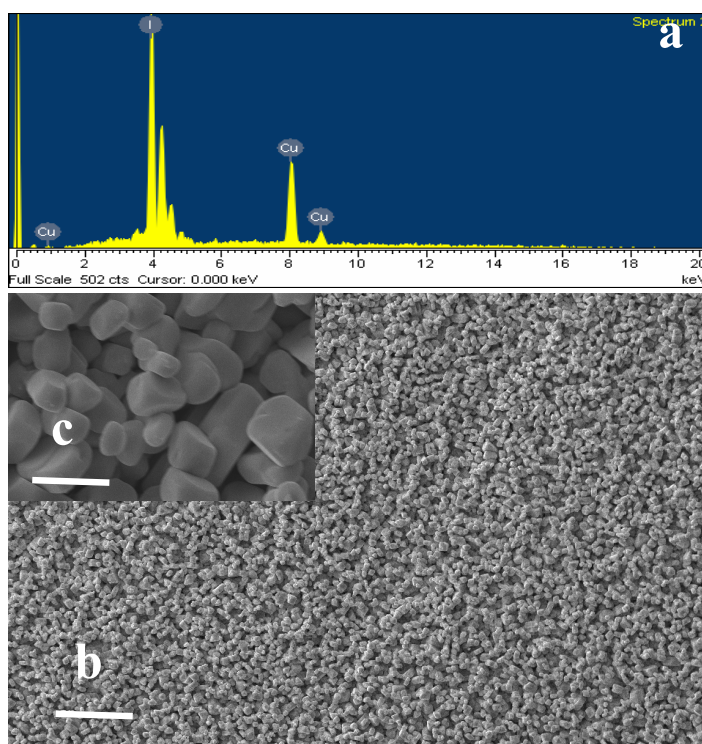
**Figure S2.** SEM images of lead iodide crystals grown on the lead foils with the iodine concentration of 0.014 g/ml in ethanol at 160 °C. Scale bar in a: 10  $\mu\text{m}$ , b: 100  $\mu\text{m}$ .



**Figure S3.** The representative XRD pattern of copper (I) iodide (CuI) crystals in-situ generated on the copper foils from I<sub>2</sub>/ethanol system with the iodine concentration of 0.007g/ml at 160 °C.



**Figure S4.** SEM images of copper (I) iodide (CuI) crystals in-situ grown on the copper foils in I<sub>2</sub>/ethanol system with the iodine concentration of 0.007 g/ml at 160 °C. Scale bar in b: 40 μm, c (enlarged image of b): 4 μm, top (a): corresponding EDX spectrum recorded from an individual cubic-like CuI crystal.



**Figure S5.** SEM image of porous  $\text{Pb}_4\text{O}_4\text{I}_{3.6}$  crystals in-situ grown on the lead foils in  $\text{I}_2/0.1\text{M NaOH}$  system with the iodine concentration of 0.014 g/ml at 160 °C.

