

Molecular beam epitaxy of single-crystalline iodide films toward the development of halide electronics

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Metal iodides have attracted great interest due to their wide variety of superior functionalities, such as the high photovoltaic efficiency in perovskite halides, transparent conductivity in CuI, ferroelectricity in SbSI, 2D excitons in BiI₃, and 2D ferromagnetism in CrI₃. For device application of these functionalities as well as exploring emergent phenomena in the heterostructures, high-quality epitaxial films are highly demanded. However, most of the metal-iodide films reported so far are polycrystalline with a high density of defects. We have recently started the growth of high-quality iodide films by employing molecular beam epitaxy (MBE). We have achieved single-crystalline films of CuI [1,2] and BiI₃ [3] with high crystallinities comparable to or even exceed bulk single crystals. In both cases, inserting a low-temperature grown buffer layer is critical to realize a coherent 2D growth. The fabricated CuI and BiI₃ films exhibit strong and sharp excitonic resonances reflecting the low defect states. We have also recently studied the photovoltaic properties of noncentrosymmetric compounds, in which the so-called “shift current” mechanism has a dominant origin [4]. SbSI is a representative narrow-bandgap ferroelectric semiconductor, and we have experimentally revealed the non-dissipative nature of the shift current using bulk crystals of SbSI [5,6]. We have also succeeded in MBE growth of SbSI thin films with an ordered polarization direction [7].

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