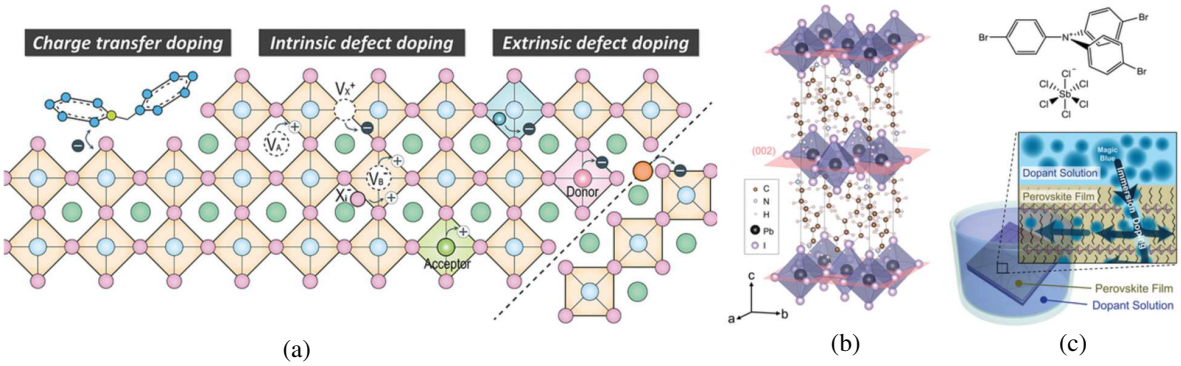
Towards Efficient Electrical Doping Strategies in Metal-halide Perovskites

Keehoon Kang
Materials Science and Engineering, Seoul National University, South Korea

Abstract— Doping has been one of the most essential methods to control charge carrier concentration in semiconductors. In metal halide perovskite (MHP), which have revolutionized the field of solar cells and light-emitting diodes due to their favorable optoelectrical properties, extensive electrical doping via conventional substitutional doping still remains challenging due to their structural stability limited by tolerance factor and compensation of intentionally introduced defects by mobile halide ions [1]. As an alternative non-invasive approach, molecular doping has been previously reported for tuning the electrical properties of MHPs [2]. However, most of the reports have been focused on charge transfer at the interface or grain boundaries which have limited the attainable doping range. In this study, we first demonstrate molecular doping with a strong *p*-dopant (magic blue) for significantly improving the electrical conductivity of low-dimensional lead perovskites [3]. We identify that dopant incorporation into the bulk of the film as the structural origin of the improved conductivity and propose the solvent selection criteria for achieving an effective bulk molecular doping. Furthermore, we have recently explored bulk doping strategies for controlling the electrical properties of 3D perovskites over a wide range of conductivity [4]. Our efficient doping methods developed will open up a controllable route towards tuning electronic structure for optimizing perovskite-based electronic and optoelectronic devices.



(a) (b) (c)

Figure 1: (a) Schematics for representing different types of doping methods available in MHPs, (b) the lattice structure of 2D perovskties and (c) our immersion molecular doping method.

REFERENCES

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