Amazing 3D and 2D Halide Perovskites: All the Things They Do

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Abstract

Three-(3D) and two-dimensional (2D) layered halide perovskites are highly promising semiconductors for optoelectronic applications ranging from solar cells, light emitting diodes, soft radiation detector, hard radiation detectors, etc. The 3D versions of these compounds adopt the three-dimensional ABX_3 perovskite structure, which consists of a network of corner-sharing BX_6 octahedra, where the B atom is a divalent metal cation (typically Ge^{2+}, Sn^{2+} or Pb^{2+}) and X is a monovalent anion (typically Cl^-, Br^-, I^-); the A cation is selected to balance the total charge and it can be a Cs^+ or a small molecular species. Another class of materials gaining significance are the two-dimensional (2D) perovskites -a blend of perovskites with layered crystal structure- (Ruddlesden-Popper type) offer a greater synthetic versatility and allow for more specialized device implementation due to the directional nature of the crystal structure. A remarkable advantage of the 2D perovskites is the readily tunable functionality by incorporating a wide array of organic cations into the 2D framework and by controlling the slab thickness, in contrast to the 3D analogues which have limited scope for structural engineering. We present the new homologous series, $(C(NH_2)_3)(CH_3NH_3)_nPb_nI_{3n+1}$ (n = 1, 2, 3), of layered 2D perovskites which is different from Ruddlesden-Popper type.

Short Biography

Mercouri G. Kanatzidis received his B.S. in chemistry from Aristotle University, Thessaloniki, Greece, in 1979 and his Ph.D. in chemistry from the University of Iowa in 1984. He was a postdoctoral research associate at Michigan and Northwestern from 1985 to 1987; a University Distinguished Professor at Michigan State from 1987 to 2006; and is currently a Charles E. and Emma H. Morrison Professor in Chemistry at Northwestern. Most recently his awards include: AIC Chemical Pioneer Award, 2018; Honorary Doctorate Degree, University of Crete, 2017; Samson Prime Minister's Prize for Innovation in Alternative Fuels for Transportation, 2016; American Physical Society James C. McGroddy Prize for New Materials, 2016; ENI Award for "Renewable Energy Prize", 2015; Royal Chemical Society De Gennes Prize, 2015; Materials Research Society Medal, 2014; American Chemical Society Award in Inorganic Chemistry 2016, and was elected Fellow, American Association for the Advancement of Science, 2012. His research has generated seminal work in metal chalcogenide chemistry through the development of novel "solvents" for solid state synthesis including flux methods, hydrothermal and solvothermal techniques. He is also active in the field of new thermoelectric materials, synthetic design of framework solids, intermetallic phases and nanocomposite materials. His work is described in more than 1,130 research publications.