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Directed Assembly of Layered Perovskite Heterostructures as Single Crystals

Researchers at Stanford have developed a new synthetic strategy for self-assembling layered heterostructures into large single crystals and films useful in microelectronics. Given the technological promise of halide perovskites, this intuitive synthetic route sets a foundation for the directed synthesis of richly structured complex semiconductors that self-assemble in water. The method may be applied to perovskites or more generally to other heterostructures with two different 2D materials. The coupling of two different inorganic lattices can form materials that show a combination of properties (e.g., a magnetic lattice and a conductive lattice can show magnetoresistance). Further, the heterostructure can show new emergent properties not seen in the individual 2D parent structures (e.g., excitons delocalized between both layers). Conventionally, most heterostructures are formed by manipulating one monolayer at a time. The new approach is much more scalable, allowing for gram-scale synthesis of heterostructures at room temperature in water.

Stage of Development
As reported in a 2021 paper in *Nature*, the new approach yields products as single crystals, crystalline powders, and thin films that can be deposited from solution.

Applications

- These material have promise in microelectronics

Advantages

- More scalable, versatile and milder than existing methods

- Allows two different 2D inorganic materials to be merged into one material
- Depending on the 2D parent materials, the functionality of the heterostructure can be different (e.g., luminescent, magnetic, conductive, photoconductive materials can be coupled using this method)

Publications

- Aubrey, Michael L., et al. "Directed assembly of layered perovskite heterostructures as single crystals." *Nature* 597.7876 (2021): 355-359.

Patents

- Published Application: WO2022266238

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