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Morphing of Inorganic Perovskite Semiconductors Without Compromising Their Functional Properties

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ABSTRACT

Traditionally, it is relatively easy to process metal materials and polymers (plastics), while ceramic and inorganic semiconductor materials are hard to process, due to their intrinsic brittleness caused by directional covalent bonds or strong electrostatic interactions among ionic species. This brittleness can degrade semiconductor performance and lead to catastrophic failures, thereby limiting their application scenarios and service lifetime. Achieving room-temperature deformability in semiconductor materials without compromising their functionality has been a long-standing goal in materials science. Recently, room-temperature ductile semiconductors have emerged, with their deformability enhanced by factors such as size effects, fewer pre-existing micro-cracks, increased dislocation activity, charge characteristics, and weak interlayer bonding in quasi-layered/van der Waals semiconductors [1].

More recently, we have discovered exceptional room-temperature plasticity in a group of all-inorganic perovskite semiconductor materials ($CsPbX_3$, X=Cl, Br, I). These materials can be morphed into distinct morphologies (such as cubic, rectangular arches, L and Z shapes) through the continuous slip of dislocations operating on multiple slip systems. The overall plastic strain can reach ~64% ± 8%, without generating cracks or cleavage. Significantly, when these materials are constructed into novel optoelectronic devices with various geometries, their functional properties and bandgap energy remain unaffected by such unprecedented deformation. As a group of important functional semiconductor materials with excellent optoelectronic performance and ambient stability, our findings suggest that all-inorganic perovskites have enormous potential for manufacturing next-generation deformable electronics and energy conversion devices [2].

KEYWORDS

Plasticity; semiconductor material; all-inorganic perovskite; deformable electronics

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