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Dynamic elasto-plastic behavior of lead-halide perovskite single crystals MARCOS REYES-MARTINEZ, Princeton University, AHMED ABDELHADY, MAKHSUD SAIDAMINOV, KAUST, DUCK YOUNG CHUNG, Argonne National Laboratory, OSMAN BAKR, KAUST, MERCOURI KANATZIDIS, Argonne National Laboratory, WOLE SOBOYEJO, YUEH-LIN LOO, Princeton University — The ease of processing hybrid organic-inorganic perovskite (HOIPs; having the general composition of ABX_3) films from solution and at mild temperatures promises the use of their unique optoelectronic properties in deformable technologies, including flexible sensors and displays. To successfully apply these materials in deformable devices, knowledge of their mechanical response to dynamic strain is necessary. We elucidate the time- and rate-dependent mechanical properties of HOIPs and an inorganic perovskite (IP) single crystal by measuring nanoindentation creep and stress relaxation. The observation of pop-in events and slip bands on the surface of the indented crystals demonstrate dislocation-mediated plastic deformation. The magnitudes of creep and relaxation of both HOIPs and IPs are similar, negating prior hypothesis that the presence of organic A-site cations alters the mechanical response of these materials. Moreover, these samples exhibit a pronounced increase in creep and stress relaxation as a function of indentation rate whose magnitudes reflect differences in the rates of nucleation and propagation of dislocations within the crystal structures of HOIPs and IP. This contribution provides understanding that is critical for designing perovskite devices capable of withstanding mechanical deformations.

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