Soft Semiconductors, Harsh Frontiers: Metal-Halide Perovskites for Space Power

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Abstract:

The rapid expansion of the space economy is pressuring established power electronics to deliver higher performance at lower cost and greater manufacturing scale. Silicon and III-V technologies remain the workhorses of space power, yet metal-halide perovskites (MHPs) are emerging as credible contenders. Although best known for terrestrial deployment, MHPs display a counterintuitive resilience to radiation that challenges conventional design logic: how do "soft" lattices persist in "hard" environments? This talk addresses that paradox by arguing that dynamic lattice response underpins tolerance. I will show how low-frequency phonons, strong electron-phonon coupling, and limited thermal conductivity together promote ultrafast, phonon-assisted reconfiguration that heals displacement damage. At the same time, I will emphasize the boundary conditions of this advantage: thermal cycling and ionizing-energy-loss pathways can frustrate self-repair, leading to vulnerability. Pronounced and non-recoverable electron-irradiation damage attributable to ionization effects will be discussed. The goal of this talk is to catalyze a broader discussion on how self-adaptive semiconductors could enable resilient, sustainable power for space and other extreme settings.