PVSPACE-25
PVSPACE
September 2025
Rome, Italy
New Generation Photovoltaics for Space

Understanding Chemical Interactions in Perovskite Solar Cells Reinforced with Multifunctional Nanofibers for Resilience in Space

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Keywords: *Nanocomposites, mechanical stability, surface chemistry, thin-film photovoltaics*

Abstract:
Current state-of-the-art Earth-sourced solar array blankets are costly to launch into orbit and lack durability against radiation and thermal effects found in lunar environments. NASA has seen promise in metal halide perovskites, which may help mitigate launch costs due to their potential for onsite fabrication and low material consumption.[1] Perovskite solar cells (PSC) rapidly advanced in the past decade to rival traditional silicon and other third-generation solar cells in their power conversion efficiency. However, the poor thermomechanical stability of the perovskite photoabsorbing layer continues to pose a major hurdle for perovskite-based photovoltaics.[2] Inspired by rebar in concrete, our initial studies improved the mechanical fracture toughness of perovskite thin films five-fold when compositing them with polymeric nanofibers. We demonstrate this approach by fabricating nanofibers via electrospinning: an inexpensive, gravity independent, scalable technique. Our studies focus on utilizing commodity polymeric nanofibers from the nylon family. The functionalized nanofiber surfaces pose an opportunity to probe chemical interactions of the nanofibers with the surrounding perovskite. Nanofiber surface chemistry can be manipulated and characterized to obtain nanofiber mats with controllable densities of Lewis base functional groups. Quantification of the mechanical and residual stress effects of perovskite incorporated into synthesized nanofiber frameworks correlates nanofiber functional group densities with mechanical properties of the resulting nanocomposite. We discuss the increases in fracture resistance energy, G_c, of the nanocomposite samples with respect to nanofiber functionalization and material selection. Ultimately, nanofiber networks mitigate PSC mechanical fragility by increasing their fracture energy several-fold while maintaining comparable morphology, chemical composition, and device efficiencies to pristine perovskite. Developing a fundamental understanding of the effects of polymer functionalization on nanofiber-perovskite composites paves the way for precise design of perovskite-based materials tailored to extreme space environments.

Conflicts of Interest
I declare no conflict of interest.

Funding
This work was supported by a NASA Space Technology Graduate Research Opportunity.

References
[1] McMillon-Brown, L.; Luther, J. M.; Peshek, T. J. *ACS Energy Lett*, **2022**, *7* (3), 1040–1042.
[2] Rolston, N.; Watson, B. L.; Bailie, C. D.; McGehee, M. D.; Bastos, J. P.; Gehlhaar, R.; Kim, J. E.; Vak, D.; Mallajosyula, A. T.; Gupta, G.; Mohite, A. D.; Dauskardt, R. H. *Extreme Mech Lett*, **2016**, *9*, 353–358.