Direct ALD of amorphous MoS2 thin films for extra-terrestrial photovoltaic applications

Sarallah Hamtaei, Sungjoon Kim, Koosha Nassiri Nazif, Crystal Nattoo, Joshua M. Carr, Leo Romanetz, Frederick U. Nitta, Obadia G. Reid, Bart Vermang, Jeffery Elam, Eric Pop

Stanford University, Stanford, CA, United States

imec, Genk, Belgium

Hasselt University, Hasselt, Belgium

EnergyVille, Genk, Belgium

Argonne National Laboratory, Lemont, IL, United States

University of Colorado, Boulder, CO, United States

National Renewable Energy Laboratory, Golden, CO, United States

The design of solar cells for space applications demands a high power-to-weight ratio and resilience against extreme environments, including proton radiation and rapid temperature fluctuations. However, existing technologies come with drawbacks: III-V materials are expensive, CdTe and CIGS rely on scarce and toxic elements, perovskites suffer from stability issues, and silicon has limited limited tolerance to space-stressors. This study investigates ultra-thin amorphous MoS2 as a viable alternative, offering a balance of affordability, environmental sustainability, and robustness. Using atomic layer deposition (ALD), we enable scalable production of photovoltaic-grade amorphous MoS2 thin films, achieving large-area coatings with exceptional uniformity, smoothness, and precise thickness control. Passivation increases the charge carrier lifetime to approximately 100 ns, highlighting the potential for high specific power in a fully encapsulated module. Additionally, unpassivated films show minimal disorder when exposed to high-energy, high-fluence proton radiation. These results highlight the promise of amorphous MoS2 for space-based photovoltaics and lay the groundwork for further studies on its long-term durability in extraterrestrial conditions.

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