2:30 PM U08
(Student) Photovoltaic Response of Thin-Film CdTe Solar Cells under Accelerated Neutron Radiation in a TRIGA Reactor Kaden Powell[1], Matthew Lund[1], Meng-Jen Wang[1], Yang Qian[1], David Magginetti[1], Matthew O. Reese[2], Edward Cazalas[1], Glenn Sjoden[1] and Heayoung P. Yoon[1,1]; [1]The University of Utah, United States; [2]National Renewable Energy Laboratory, United States

Cadmium telluride (CdTe) solar cells are a promising photovoltaic (PV) technology for producing power in space owing to their high-efficiency (> 22.1 %), potential for specific power, and cost-effective manufacturing processes. In contrast to traditional space PVs, the high-Z (atomic number) CdTe absorbers can be intrinsically robust under extreme space radiation, offering long-term stability. Despite these advantages, the performance assessment of CdTe solar cells under high-energy particle irradiation (e.g., photons, neutrons, charged particles) is limited in the literature, and their stability is not comprehensively studied. In this work, we present the PV response of *n*-CdS / *p*-CdTe PVs under accelerated neutron irradiation. We measure PV properties of the devices at different neutron/photon doses. The equivalent dose deposited in the CdTe samples is simulated with deterministic and Monte Carlo radiation transport methods. Thin-film CdTe solar cells were synthesized on a fluorine-doped tin oxide (FTO) coated glass substrate (≈ 4 cm × 4 cm). CdS:O (≈ 100 nm) was reactively RF sputtered in an oxygen/argon ambient followed by a close-spaced sublimation deposition of CdTe (≈ 3.5 µm) in an oxygen/helium ambient. The sample was exposed to a 10 min vapor $CdCl_2$ in oxygen/helium ambient at 430°C. The samples were exposed to a wet $CuCl_2$ solution prior to anneal 200°C. A gold back-contact was formed on CdTe via thermal evaporation. The final sample contains 16 CdTe devices. For neutron irradiation, we cleaved the CdTe substrate into four samples and exposed two samples to ≈ 90 kW reactor power neutron radiation for 5.5 hours and 8.2 hours, respectively, in our TRIGA (Training, Research, Isotopes, General Atomics) reactor. We observed a noticeable color change of the glass substrates to brown after the neutron/gamma reactor exposure. Presumably, the injected high-energy neutrons caused the breaking of chemical bonds and the displacement of atoms in the glass substrates, creating point defects and color centers. The *I-V* characteristics showed noticeable deterioration with over 8 hour radiations. Specifically, the saturation current of the control devices was ≈ 25 nA increasing to 1 µA and 10 µA for the 5.5-hour and 8.2-hour radiated samples, respectively. The turn-on voltage of the control devices (≈ 0.85 V) decreased with the irradiated sample (≈ 0.75 V for 5.5-hour and ≈ 0.5 V for 8.2-hour exposures), implying noticeable radiation damage occurred at the heterojunction. The higher values of the ideality factor for irradiated devices ($n > 2.2$) compared to that of the control devices ($n \approx 1.3$) also support the deterioration of the *p-n* junction. We observed the notable decrease in shunt resistance (R_{SH}) and the increase in series resistance (R_s) with the neutron dose. It is possible that Cu ions introduced during the $CuCl_2$ treatment may migrate into CdTe grain boundaries (GBs). The presence of Cu ions at GBs can create additional leakage paths for photocarrier transport, deteriorating the overall PV performance. We estimated the radiation dose of CdTe in comparison to Si (conventional PV) using a UUTR model (e.g., MCNP6 2D UTR Reactor simulations). In this model, we simulated Si and CdTe at the center point of the triangular fuel lattice and used an "unperturbed flux" tally in the water. Our simulations yielded a dose rate of 6916 Gy/s of neutrons and 16 Gy/s of photons for CdTe, and 1 Gy/s of neutrons and 21 Gy/s of photons for Si (doses +/- <1%). The large dose rate of neutrons in CdTe is mainly attributed to the large thermal neutron absorption cross-section of ^{113}Cd. Based on this estimation, we calculate that the exposure of our CdTe PVs is equivalent to several million years in LEO (Low-Earth Orbit), or about 10,000 years for Si in LEO. Currently, we are working on a low-dose neutron/photon radiation on CdTe PVs and their light *I-Vs* and microstructural characterizations to gain better understanding on the degradation of CdTe PVs.