Applications and Challenges: Novel III-V and Metal-halide Perovskite Space Solar Cells

Seth M. Hubbard[1]

[1] *Rochester Institute of Technology, Rochester, New York, USA.*
[*] *smhsps@rit.edu*

Keywords:

Abstract:
Recently, near earth space has undergone a rapid commercialization, in part due to the expansion of satellite based internet service, resulting in a rapid increase in the number of satellites in low earth orbit, currently at just over 11,000 spacecrafts. This has resulted in an increased demand for the solar cell materials needed to power these satellites. In this talk, I will review the work being conducted though our Space Strategic Technology Institute (SSTI-3) Center, focused on developing lower-cost, sustainable solar cells that can be used in the harsh radiation and temperature extremes of space. One focus is on metal-halide perovskites (MHPs), which combine ease of manufacturing, ultralow materials costs, and the potential for exceptionally high specific power with a remarkable radiation tolerance. In particular, our team has carried out systematic proton and electron irradiation of various space-relevant metal-halide perovskite (MHP) thin films to understand and optimize the MHP chemistry for space resilience. These radiation tests were carried out at fluences typically experienced in LEO over 2–5-year missions. The focus here is to isolate the effects of radiation in the MHP layers. The irradiated films have been characterized using X-ray diffraction, UV-Vis-NIR absorption spectroscopy, photoluminescence, and scanning electron microscopy, to understand the impact of space radiation on MHPs at the atomic level. Recovery of the power remaining factor in MHP solar cells was observed, to proton fluence as high as $1x10^{15}$ p^{+}/cm^{2}, well beyond typical doses seen during a LEO mission. However, unlike protons, electron irradiation caused significant degradation of the MHP films at fluences as low as $1x10^{14}$ e^{-}/cm^{2}. This may highlight the acute differences between non-ionizing energy loss (NIEL) and ionizing loss (IEL), leading to thermal degradation of MHP films. Further studies are ongoing and will reveal the underlying healing mechanism in perovskites. A second focus at RIT is on quantum well based III-V solar cells, as an efficient way to achieve current matching between the subcells of traditional multi-junction devices. The potential here is to increase efficiency and at the same time reduce device complexity and operating temperature. Our team has recently completed extensive radiation, thermal cycling and maximum power point testing on QW devices to determine space readiness. These results will be discussed as well as reviewing current state-of-the-art.

Conflicts of Interest
Please declare that there is no conflict of interest.

Funding
United States Space Force, Air Force Research Laboratory