stable defect complexes. Ionizing radiation is also a large detriment to the other materials associated with space solar arrays. It causes trapped charges to be created in silicon dioxide passivating layers that can lead to increased leakage currents. Ionizing radiation, including ultraviolet photons, is particularity bad for organic materials such as polymers used in array development as it can produce ions, free electrons, and free radicals that can dramatically change the optical, electrical, and mechanical properties of these materials.

The loss of energy of the high-energy protons and electrons due to interactions with electrons in a material accounts for a large fraction of the dissipated energy. In fact, these collisions are used to determine the penetration range for the electrons and protons in the 0.1 to 10 MeV range. However, it is the atomic displacements created by irradiation that are the major cause of degradation in space solar cells.

The displacement of an atom from a lattice site requires energy similar to that necessary to sublime an atom or to create a vacancy. The energy of sublimation for Si is 4.9 eV and for vacancy formation is 2.3 eV. The displacement of an atom requires the formation of a vacancy, an interstitial, and usually the creation of some phonons. Therefore, to create a displacement will require energy several times larger than that to create a vacancy.

The main importance of displacement defects due to irradiation is their effect on minority carrier lifetime. The lifetime in the bulk *p*-type material of a Si solar cell is the major radiation-sensitive parameter. This was the basis for the switch from *p*-on-*n* to *n*-on-*p* Si solar cells in the 1960s [21]. The minority carrier lifetime or diffusion length in an irradiated solar cell may be a function of excess or nonequilibrium minority carriers. This behavior is referred to as injection level dependence. This is usually associated with damage due to high-energy protons.

The primary radiation defects in Si are highly mobile. The radiation damage effects in Si are primarily due to the interaction of primary defects with themselves and with impurities in the material. Radiation damage in these cells can be mitigated to a certain extent by removing some of the damage before it becomes consolidated. Radiation-resistant Si cells use intrinsic gettering to remove a part of the radiation damage while it is still mobile. These cells contain a relatively pure region near the surface or “denuded zone” with a gettering zone rich in oxygen deeper in the wafer away from the junction. Although this approach decreases the beginning-of-life (BOL) output, it increases the end-of-life (EOL) output. The cells are much more radiation-resistant, which can dramatically extend the mission lifetime.

Annealing of irradiated solar cells can be used to remove some of the damage, although not at temperatures that would be considered practical for space applications. Temperatures of nearly 400°C are required for significant improvement in Si cells. However, there is some amount of ambient annealing of radiation damage that can occur. In space the damage and annealing process are occurring simultaneously and are thus hard to quantify. However, in the lab, ambient annealing improvement of as much as 20% in the short-circuit current has been observed after 22 months.

The main method for mitigating radiation damage in space solar cells is to prevent damage by employing a cover glass. The cover glass not only stops the low-energy protons but also slows down the high-energy particles. It can also serve to stop micrometeors,