An 80-Year-Old Equation is Surpassed by a New Solar Cell Model.

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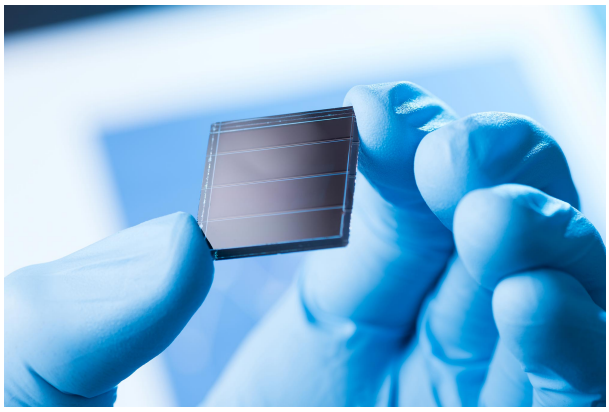

Courtesy of SynEvol

By developing a new analytical model, physicists at Åbo Akademi University and Swansea University have made a significant development in solar cell technology. The comprehension and effectiveness of thin-film photovoltaic (PV) devices are improved by this concept.

The electrical current that powers your home or charges the battery bank passes via solar cells, and this process has been explained for almost eight decades by the so-called Shockley diode equation. The latest study, however, casts doubt on this conventional wisdom for a particular class of next-generation solar cells, specifically thin-film solar cells.

These flexible, inexpensive thin-film solar cells' low efficiency has been caused by a number of issues that the current analytical models are unable to adequately account for.

The latest research provides insight into how these solar cells attain maximum efficiency. It demonstrates a crucial equilibrium between storing the energy produced by light and reducing losses from recombination, the process by which electrical charges cancel each other out.

The primary author, Dr. Oskar Sandberg of Åbo Akademi University in Finland, stated, "Our findings provide key insights into the mechanisms driving and limiting charge collection, and ultimately the power-conversion efficiency, in low-mobility PV devices."

A blind area existed in earlier analytical models for these solar cells due to "injected carriers," or charges that entered the device through the connections. These carriers have a major effect on limiting efficiency and recombination.

"Especially for these thin-film cells with low-mobility semiconductors, the traditional models just weren't capturing the whole picture," Swansea University Associate Professor Ardalan Armin, the lead scientist, said. "In order to fill this vacuum, we have developed a new diode equation that takes into consideration these important injected carriers and their recombination with those photogenerated."

"In conventional solar cells, like silicon PV, which is hundreds of times thicker than next-generation thin film PV, like organic solar cells, the recombination between injected charges and photogenerated ones is not a major problem," Dr. Sandberg continued. One of the greatest theoretical physicists of all time, Wolfgang Pauli, famously remarked, "God made the bulk; the surface was the work of the devil."

Associate Professor Armin declared as much. Thin film solar cells are more susceptible to "the work of the devil"—the recombination of valuable photogenerated charges with injected ones near the interface—than standard silicon because they contain substantially larger interfacial regions per bulk.

This novel model provides a new framework for material property analysis, device optimization, and the creation of thinner solar cells and photodetectors with higher efficiency. Additionally, it can help train machines for device optimization, which is a big step forward for the creation of next-generation thin-film solar cells.