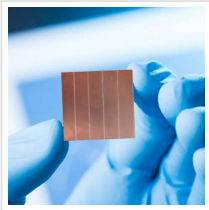
Perovskite Solar Cell with Cesium-Titanium Dioxide Nanotubes



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A global research group has developed a perovskite PV cell with titanium dioxide nanotubes doped with cesium. It purportedly offers better short-circuit current and power conversion efficiency than cells without cesium nanoparticles. They say it has optimal thermal stability under temperatures up to 800 C.

An international research group has developed a perovskite solar cell with strong thermal stability and enhanced electron injection by using special nanotubes made of cesium-titanium dioxide (Cs-TiO2).

The scientists used titanium sheets with 99.4% purity, 1 mm thickness, and a length of 50 mm. The cell was fabricated with a two-step electrochemical anodization process and was then encapsulated with Cs nanoparticles, after being doped with a Cs-based solution. The C2-TiO2 nanotubes were then annealed at 450 C. The solar cell is based on methylammonium lead triiodide (CH3NH3PbI3), which is a perovskite with high photoluminescence quantum yield.

The researchers fabricated the nanotubes with a regular, ordered structure, which they say is necessary to achieve high levels of power conversion efficiency in the solar cell. This efficiency is proportional to the length of the nanotubes themselves.

“If the nanotube length is in between 1 micrometer (µm) to 20 µm then the incident photon-to-current conversion efficiency (IPCE) increases and reaches up to 80% at 20 µm length resulting in an increase in the efficiency of perovskite solar cells,” they said, adding that 20 µm is a reasonable distance for an electron to travel and to achieve higher efficiency.

The academics said that the metal ions of the dopant material they used to produce the

nanotubes have a better ability to accept electrons.

“The doped metal can easily trap the conduction electrons enabling the reduction in electron-hole pair recombination,” they said.

They used ultraviolet-visible spectroscopy (UV-Vis) to compare the performance of their solar cell with a similar cell designed with TiO2 nanotubes without Cs doping. The thermal performance of the two devices was measured through thermal gravimetric analysis (TGA). The thermal assessment showed that the doped nanotubes have excellent thermal stability under temperatures ranging up to 800 C. They also found that they lose roughly 1% of their weight at around 150 C.

The analysis showed that cesium atom doping effectively facilitates electron transport by reducing recombination reactions. The researchers said that the Cs-TiO2 based perovskite solar cell exhibited superior performance, resulting in an 18.67% jump in short-circuit current and a 22.28% increase in power conversion efficiency from the reference cell. “The doping process can be performed at a low cost, as we used an optimized concentration of cesium of only 0.05 M,” research principal author, H.M. Asif Javed, told pv magazine.

“The improvement in solar cell parameters can be attributed to enhanced extraction of the photo-generated charge carriers in the device,” the researchers concluded.

They described the cell in “Encapsulation of TiO2 nanotubes with Cs nanoparticles to enhance electron injection and thermal stability of perovskite solar cells,” which was recently published in Surfaces and Interfaces. The research team included scientists from Pakistan's University of Agriculture Faisalabad and the National University of Sciences and Technology, China's Xi'an Jiao Tong University and Jiangsu University, and King Saud University in Saudi Arabia.

Read the original article on PV MAGAZINE .