Researchers make key improvement in solar cell technology

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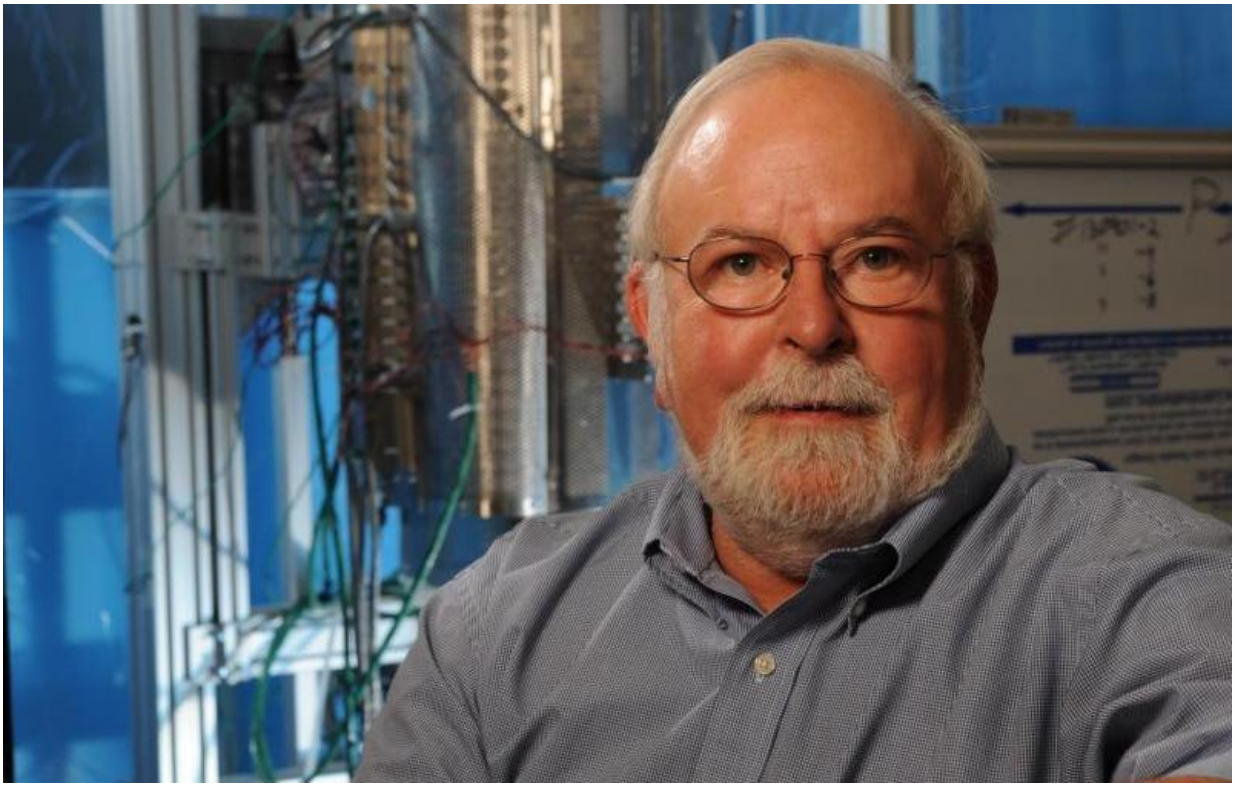

Kelvin Lynn, a Regents professor in the Washington State University School of Mechanical and Materials Engineering and Department of Physics, helped researchers reach a milestone in solar cell fabrication. Credit: Washington State University

Researchers have reached a critical milestone in solar cell fabrication,

helping pave the way for solar energy to directly compete with electricity generated by conventional energy sources.

Led by the U.S. Department of Energy's National Renewable Energy Laboratory and in collaboration with Washington State University and the University of Tennessee, the researchers improved the maximum voltage available from a cadmium telluride (CdTe) solar cell, overcoming a practical limit that has been pursued for six decades and is key to improving its efficiency. The work is published in the Feb. 29 issue of *Nature Energy*.

Silicon solar cells currently represent 90% of the solar cell market, but it will be difficult to significantly reduce their manufacturing costs. CdTe solar cells offer a low-cost alternative. They have the lowest carbon footprint of any other solar technology and perform better than silicon in real world conditions, including in hot, humid weather and under low light. However, until recently, CdTe cells haven't been as efficient as silicon-based cells.

One key area where CdTe has underperformed was in the maximum voltage available from the solar cell, called open-circuit voltage. Limited by the quality of CdTe materials, researchers for the past 60 years were not able to get more than 900 millivolts out of the material, which was considered its practical limit.

The research team improved cell voltage by shifting away from a standard processing step using cadmium chloride. Instead, they placed a small number of phosphorus atoms on tellurium lattice sites and then carefully formed ideal interfaces between materials with different atomic spacing to complete the solar cell. This approach improved the CdTe conductivity and carrier lifetime each by orders of magnitude, thereby enabling the fabrication of CdTe solar cells with an open-circuit voltage breaking the 1-volt barrier for the first time. The innovation

establishes new research paths for solar cells to become more efficient and provide electricity at lower cost than fossil fuels.

"It's a significant milestone. It's been below 900 millivolts for decades," said Kelvin Lynn, Regents professor in WSU's School of Mechanical and Materials Engineering and Department of Physics, who led WSU's effort.

The NREL researchers treated the crystals, built and characterized the solar cells, while WSU researchers, including Santosh Swain and Tursun Ablekim, developed -the crystal material used in the cells. The WSU researchers grow their crystals in a technique called melt growth, which allows precise control over purity and composition. Purity is extremely critical to the process, so the researchers mix, prepare and vacuum-seal the materials in an industry-standard clean room. They then synthesize the crystal in a furnace above 1100 degree °C and then cool it from the bottom up at a rate of about one millimeter per hour. The researchers then cut the crystal into polished wafers to make the solar cells.

"Others have tried dopants, but they didn't have the control and purity that we have. And, the purity matters," said Lynn. "WSU is known for growing really high quality and purity crystals. You have to control every step."

While researchers have improved silicon-based cells almost to their theoretical limit, there is significant room for efficiency improvements for cadmium telluride, which could be bettered by an additional 30 percent, said Lynn.

More information: "CdTe solar cells with open-circuit voltage breaking the 1 V barrier," *Nature Energy* (2016). DOI: 10.1038/nenergy.2016.15

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