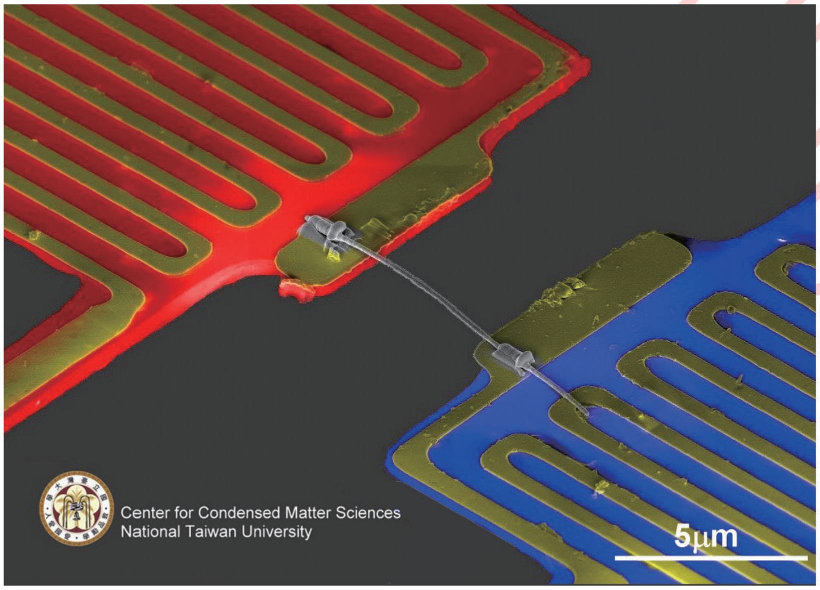

A tailored microscale platform for measuring phonon transport across an individual nanowire.

Toward low-cost and high-efficiency solar cells by solution processing

Global warming has led to ice in the Arctic and Antarctic to melt at an unprecedented rapid rate, and the excess water has caused many severe natural disasters worldwide. Solar cells are the most promising technology for producing renewable clean energy to meet the conditions of the 2015 Paris agreement signed by world leaders. The agreement calls to limit the global temperature rise tolower than 2°C, which requires CO_2 emissions to be reduced to at least 20% of the current amount by 2050 and 0% by 2100. However, the cost of generating electricity using Si solar cells is three times higher than that of burning fossil fuels. Recently, a new class of thin film solar cells, perovskite solar cells, has emerged as a technology that costs one-tenth of that of Si solar cells. Perovskite solar cells are fabricated from low-cost organic-inorganic perovskite materials using conventional solution processing.

The research group led by Professor Wei-Fang Su and Dr. Leeyih Wang, in the Department of Materials Science and Engineering and the Center for Condensed Matter Sciences at National Taiwan University, is the world leader in an effort to scale up and commercialize this technology. The team has studied the fundamental formation mechanism of crystalline perovskites using scanning tunneling microscopy, X-ray spectroscopy and scanning electron microscopy [1,2]. The results provide useful guidelines for controlling the composition, crystallization and morphology of perovskite films. Power conversion efficiencies of 18.2% for a small sized single cell and 12% for a 5 cm x 5 cm module of eight cells have been achieved [3].

Moreover, interface engineering of the TiO_2 electron-transport layer with amino acids can induce alignment of the (110) plane of the perovskite crystallites perpendicular to the TiO_2 surface. This preferential orientation of the perovskite crystals near the interface reduces the charge transfer resistance at the $TiO_2/CH_3NH_3PbI_3$ interface, leading to a considerable enhancement in photovoltaic performance [4]. Professor Su and Dr. Wang have also demonstrated that the incorporation of a rigid quinoid core, [3,6-di(2H-imidazol-2-ylidene) cyclohexa-1,4-diene], into conjugated molecules can substantially improve the ordered intermolecular packing. This arylamine-free compound exhibits good hole mobility and can be employed as a highly efficient dopant-free hole-transport material [5]. Importantly, the extremely dense packing structure and high hydrophilicity provide durable resistance against the environmental humidity, effectively increasing the operational lifetime of the solar devices. Currently, the team is working on the development of highly transparent perovskite solar cells that can be joined with Si solar cells to produce tandem solar cells with power conversion efficiencies greater than 25%.

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