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Scaled-up perovskite solar cells prove their conversion power

Multicoloured and semi-transparent solar cells made of perovskite have been shown to display the highest power conversion efficiency when they are scaled up.

A research team at Nanyang Technological University (NTU) has created a 21 sq cm solar cell module with a power conversion efficiency of 18.1 per cent – the highest reported value for perovskite solar modules so far.

Its findings were published in the journal Joule on April 2, in a paper titled Highly Efficient Thermally Co-Evaporated Perovskite Solar Cells And Mini-modules.

Perovskite is a material made of elements such as carbon, hydrogen, nitrogen, lead and iodine. It has been identified as a promising alternative to traditional silicon-made solar panels owing to its lightweight quality and flexibility.

Perovskite-made solar cells no bigger than 1 sq cm have achieved a power conversion efficiency of 25.2 per cent, comparable to the 26.6 per cent efficiency of their silicon counterparts. Commercial silicon solar panels, typically 17,000 sq cm in size, have a power conversion efficiency ranging from 17 per cent to 22 per cent under standard testing conditions.

Past efforts to scale up perovskite cells for commercial use while maintaining power conversion efficiency have been difficult.

Dr Annalisa Bruno, senior scientist at NTU's Energy Research Institute, said: "The best-performing perovskite solar cells have so far been realised in the laboratory at sizes much smaller than 1 sq cm, using a solution-based technique called 'spin-coating'."

But when this method was used on a larger surface, it resulted in lower power conversion efficiencies in perovskite solar cells due to limitations such as the lack of uniformity over large areas.

Instead, using thermal co-evaporation – a common industrial technique – to form the perovskite layer, the researchers could produce the highest recorded power conversion of any perovskite-based device larger than 10 sq cm.

Dr Bruno said: "Our work demonstrates the compatibility of perovskite technology with industrial processes and its potential for market entry. This is good news for Singapore, which is looking to ramp up the use of solar technology."

Professor Subodh Mhaisalkar, NTU associate vice-president and co-lead author of the paper, said the findings would allow Singapore to harness the power of sunlight more efficiently. The semi-transparent, coloured perovskite solar cells "can be used on facades and windows in skyscrapers, which is not possible with current silicon solar panels as they are opaque and block light".

Also, the perovskite solar cells show high potential as enablers of smart sensors and indoor light harvesting devices, which the researchers hope to deploy as part of NTU's Smart Campus initiative.

The team is looking to develop perovskite solar cells that can be stacked on silicon cells to create perovskite-silicon tandem solar modules. This could potentially generate 30 per cent to 40 per cent more electricity per unit area compared with the existing silicon solar panels.

But to achieve this, the tandem solar cells have to be scaled to approximately 240 sq cm – the next challenge for researchers.

"We are hoping to deploy these tandem solar cells on rooftops, particularly in land-scarce and high-rise cities like Singapore, where maximising the generation of electricity per unit area is all the more essential," said Dr Bruno.

Cheryl Tan

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(From left) Dr Li Jia, Dr Annalisa Bruno, Associate Professor Nripan Mathews and Dr Wang Hao with the 21 sq cm perovskite solar cell modules created by their team at Nanyang Technological University. Using an industrial technique to form the perovskite layer, the team could produce the highest recorded power conversion of any perovskite-based device larger than 10 sq cm. PHOTO: NTU