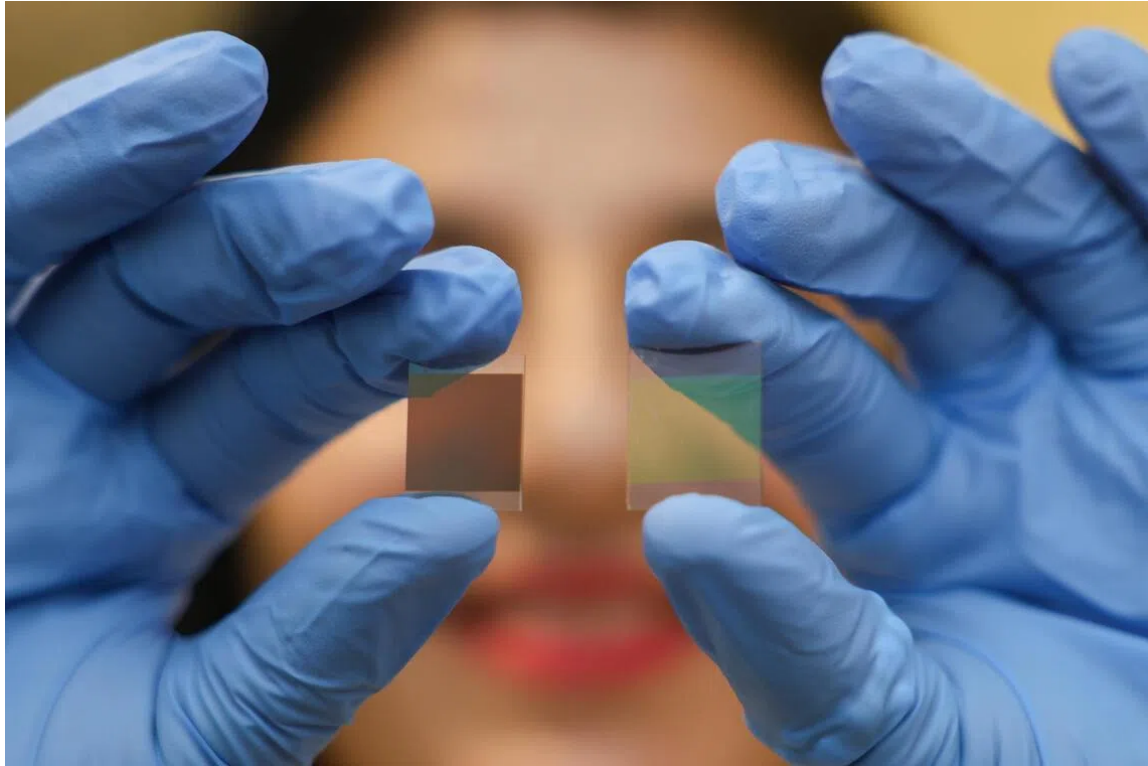


Solar-powered cars? NTU team creates ultra-thin, semi-transparent solar cells that may go on windows

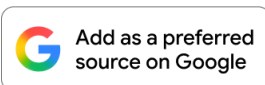
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Associate Professor Annalisa Bruno, from the School of Physical and Mathematical Sciences and School of Materials Science and Engineering at NTU, holding up a 400nm film (left) and a 10nm film that was developed by researchers at the Energy Research Institute @ NTU.

ST PHOTO: JASEL POH

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SINGAPORE – Instead of the huge black panels that often cover roofs, solar panels could be practically invisible, blending into glass windows, after scientists from the Nanyang Technological

University (NTU) developed a solar cell that is ultra-thin and semi-transparent.

Most solar panels are currently made of silicon. The solar cells developed by a research team from NTU's Energy Research Institute use an earth-abundant semiconductor material called perovskite that was first used in solar panels in 2009. This material allows for significantly more control over opacity and colour than silicon.

Perovskite solar cells are also different from conventional solar panels in their ability to generate energy even under indirect or diffused light. This [could be significant in Singapore's urban environment](#), where surrounding tall buildings may prevent direct sunlight from reaching some solar panels.

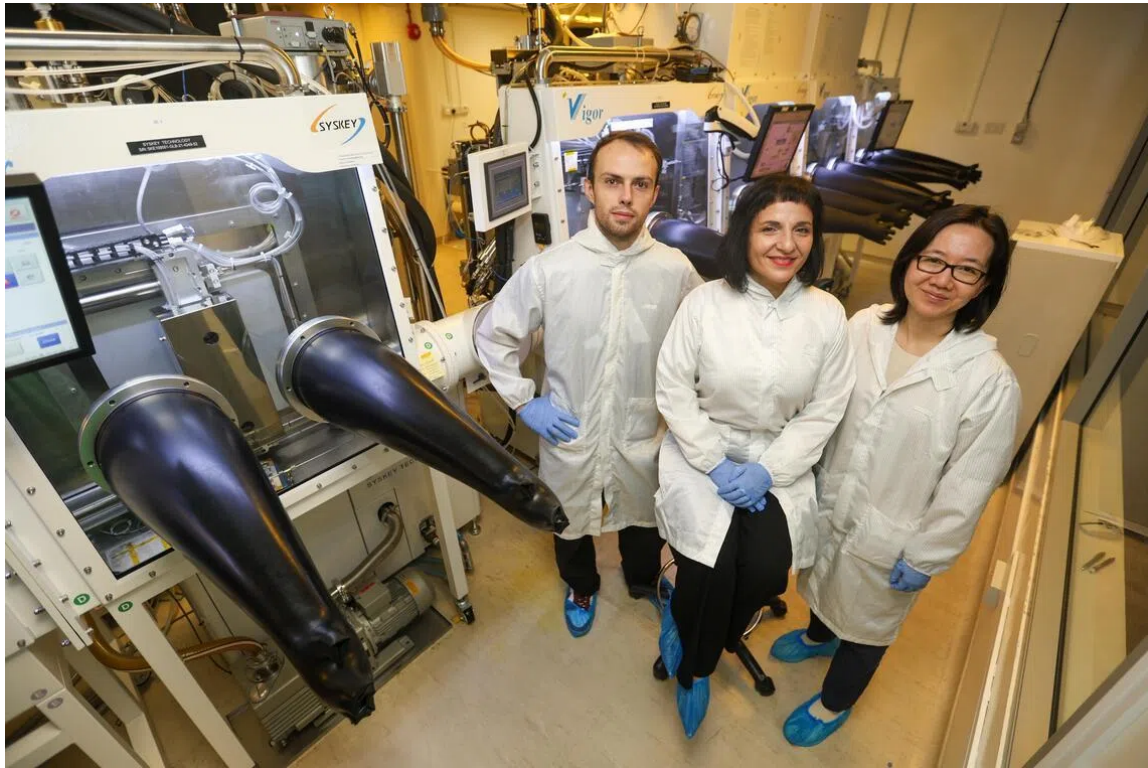
Semi-transparent solar cells also hold the potential for self-sufficient electric cars or wearable electronics as they can charge any time they are under the sun.

Compared with silicon, perovskite is comparatively new and still being researched, although it has high potential for use in solar panels. Silicon-manufacturing processes are also more established and cheaper than perovskite ones, although perovskite may become more cost-efficient after initial start-up costs, according to research from Tsinghua University.

Using a process called thermal evaporation, the NTU team is able to create an extremely thin perovskite layer over a large area. It believes this is the first time ultra-thin perovskite solar cells have been created using entirely vacuum-based processes.

“A typical perovskite layer is around 700 nanometres (nm). Now, we have moved from 700nm down to 10,” said the team leader, Associate Professor Annalisa Bruno, from NTU's School of Physical and Mathematical Sciences and School of Materials Science and Engineering. For reference, a strand of human hair is typically about

100,000nm thick. This is 10,000 times thicker than the perovskite layers used in the cells developed by Prof Bruno's team.



(From left) NTU researchers Edoardo Albanesi, Annalisa Bruno and Herlina Dewi in the laboratory at the Energy Research Institute @ NTU.

ST PHOTO: JASEL POH

Opaque silicon solar panels tend to have an energy conversion efficiency of about 25 to 27 per cent at the highest levels, while 60nm perovskite solar cells developed by Prof Bruno's team have 7.6 per cent efficiency.

“The results reported (in the NTU project) show a promising balance between transparency and power generation in very thin devices, while the next critical tests will be long-term stability, durability and performance over larger areas,” said Professor Sam Stranks, who teaches energy materials and optoelectronics at the Department of Chemical Engineering and Biotechnology at the University of Cambridge, and was not involved in the project.



NTU researcher Edoardo Albanesi using pincers to pick up a piece of thin film at the Energy Research Institute @ NTU.

ST PHOTO: JASEL POH

While ultra-thin layers are generally less efficient than thicker ones, the researchers stated that they had the highest reported efficiency among groups working on similar projects, including those with cells that are closer to 300nm in width.

Semi-transparent solar cells have been the focus of much research as they would allow electricity to be generated unobtrusively near where it is needed, reducing the burden on power grids. This could allow for more buildings to achieve net-zero status, in line with the aim of the Building and Construction Agency (BCA) for Singapore's built environment to reach net-zero emissions by 2050.

The core technology used to produce the ultra-thin perovskite layer has been patented under NTU in Singapore and the US. The research team is in talks with an undisclosed company to explore the manufacturing of the solar cells on a larger scale. Prof Bruno and her team estimate that it would take three to five years to scale up from

the prototype to commercial use, although this may depend on the rate of adoption by industry partners.

The five-year solar cell project was primarily funded by NTU and grants from the Ministry of Education. The team also received support from the National Research Foundation and Economic Development Board.

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