

NTU develops ultra-thin transparent solar cells

News

Researchers at Nanyang Technological University in Singapore have developed ultra-thin, semi-transparent perovskite solar cells designed for integration into buildings, vehicles and wearable devices.



NTU research fellow Dr Daniela De Luca examining a prototype ultrathin perovskite solar cell in the vacuum chamber in the lab - NTU Singapore

The research team, led by Annalisa Bruno, reported that the new devices are approximately 50 times thinner than conventional perovskite solar cells while maintaining comparatively high power conversion efficiencies for ultrathin designs. Their work is detailed in [ACS Energy Letters](#).

According to the researchers, the cells could be incorporated into surfaces such as windows and façades without significantly altering their appearance due to their semi-transparent and colour-neutral properties. The technology is also intended for environments where direct sunlight is limited.

“The built environment accounts for roughly 40 per cent of global energy consumption, so technologies that seamlessly convert buildings’ surfaces into power-generating assets are gaining urgency,” said Assoc Prof Bruno, from [NTU’s](#) School of Physical and Mathematical Sciences and School of Materials Science and Engineering. “Our perovskite solar cells offer distinct advantages as they can be manufactured using simple processes at relatively low temperatures. They can also be tuned to absorb specific wavelengths while

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Perovskite solar cells use layered structures that include a semiconductor material capable of absorbing sunlight and converting it into electrical energy. Unlike silicon-based solar panels, the devices can continue generating electricity under indirect or diffuse lighting conditions, which the researchers said makes them suitable for dense urban environments and regions with frequent cloud cover.

The NTU team manufactured the solar cells using thermal evaporation, a vacuum-based deposition process in which materials are heated until they vaporise and form thin films on a surface. The researchers said the method enabled the production of highly uniform ultrathin layers across larger areas while avoiding the use of toxic solvents and reducing defects within the cells.

By modifying the deposition process, the team was able to control the thickness of the perovskite layer and produce both opaque and semi-transparent devices. The researchers believe this is the first demonstration of ultrathin perovskite solar cells fabricated entirely through vacuum-based processes, which they said may improve compatibility with industrial-scale production methods.

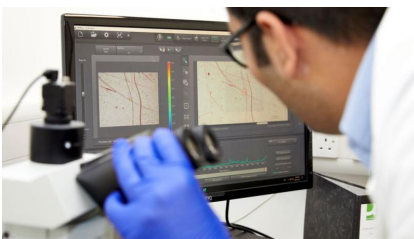
Using the process, the researchers produced absorber layers as thin as 10nm. Opaque devices with perovskite layers measuring 10nm, 30nm and 60nm achieved power conversion efficiencies of around seven per cent, 11 per cent and 12 per cent respectively.

The team also developed a semi-transparent solar cell using a 60nm perovskite layer. The device transmitted approximately 41 per cent of visible light while achieving a conversion efficiency of 7.6 per cent. The researchers said the performance ranks among the strongest reported for comparable semi-transparent perovskite solar cells.

The team has filed a patent for the technology through NTUitive and is currently working with industry partners to validate and standardise the thermal evaporation manufacturing process. Further work will focus on improving long-term stability, durability and large-area performance ahead of potential commercial deployment.

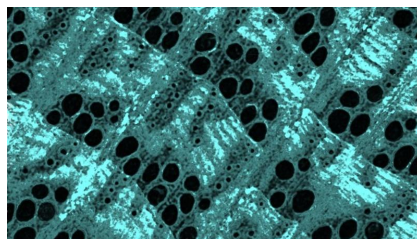
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