Enhancing solar efficiency with upconversion

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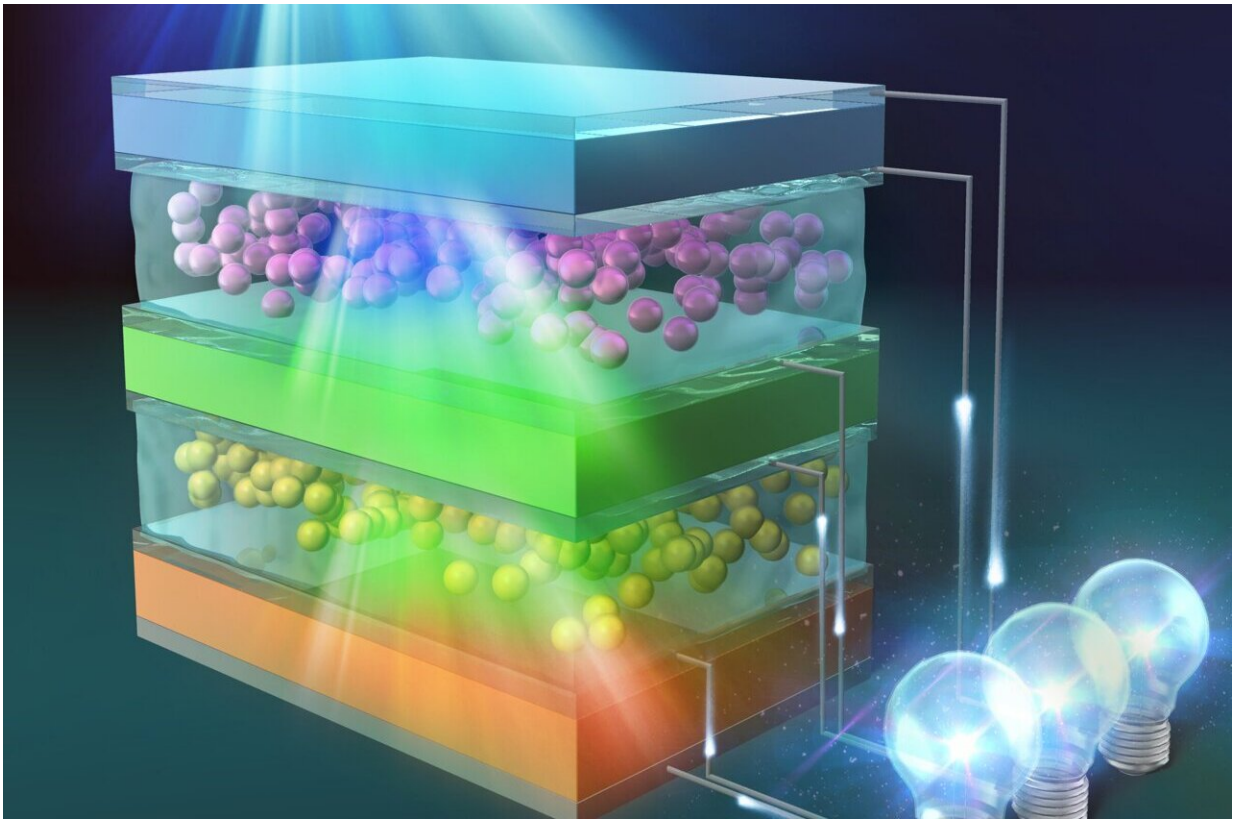

Semiconductor bonding mediated by upconversion material. Credit: KyotoU/Katsuaki Tanabe

Solar cell technologies have been improving incrementally over the decades, but energy conversion has remained less than optimal.

Now, researchers at Kyoto University have developed a novel wafer

bonding technology using an optical upconversion material that transforms sunlight to shorter-wavelengths. This new semiconductor process utilizes the interface's optical function for bond formation.

The team created a stacked structure consisting of a thin silicon film mimicking the upper subcell of a multi-junction solar cell and a silicon solar cell wafer; these layers were bonded with an adhesive made from upconversion nanoparticles dispersed in a hydrogel.

Conventional multi-junction solar cells are created with the vapor phase growth method. However, this method is limited by lattice matching in semiconductor materials.

The team, led by Katsuaki Tanabe, have applied their wafer bonding method to the production of a range of optical and electronic devices, demonstrating that different semiconductor materials can be stacked in any combination without the restriction of lattice matching.

"Even inherently non-absorbed light of longer wavelengths in the lower subcell of a multi-junction solar cell could be used to enhance the efficiency of the overall energy conversion via our upconverting interface," concludes the author.

The research was published in *Applied Physics Letters*.

More information: Naoki Sano et al, Upconversion semiconductor interfaces by wafer bonding for photovoltaic applications, *Applied Physics Letters* (2022). DOI: 10.1063/5.0097427

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