Atomically thin building blocks could make optoelectrical devices more efficient

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Researchers at Purdue University have developed new heterostructures that could make optoelectrical devices, such as solar panels and sensors, more efficient.

Heterostructures are made by stacking layers of two-dimensional materials. Here, the researchers stacked two very thin materials, tungsten disulfide and graphene, to see if they would work together to create electricity.

"If you wanted to add a different material on top of silicon, which is often used in solar cells, it would be very difficult because there would be a mismatch between the materials," said Libai Huang, a professor of chemistry in Purdue's College of Science, who led the research. "But these atomically thin layers allow you to build like Legos. This opens up a lot of new ways of designing functionality."

Graphene, which is a form of carbon, is good at moving electrons. Carbon atoms form bonds that electrons can use to move around quickly; the faster the electrons move, the more efficient the electrical current they create. For comparison, electrons can move more than 1,000 times faster in graphene than in silicon.

Using the interaction between graphene and tungsten disulfide to generate a current, though, was a new idea.

Tungsten disulfide has a bandgap, an energy range where no electrons can exist, which dictates the minimum energy that can be absorbed. Tungsten disulfide's bandgap is two electron volts, which means only light with more than two electron volts can be absorbed. By adding a layer of graphene, Huang's team was able to move the electron from the graphene to the tungsten disulfide, which requires less energy than the bandgap. This means even light with less than two electron volts could be used to create energy.

The applications aren't just limited to solar cells, said Huang. This mechanism could be used to create new properties in materials used in transistors, sensors and more.

More information: Long Yuan et al. Photocarrier generation from interlayer charge-transfer transitions in WS 2 -graphene heterostructures, *Science Advances* (2018). DOI: 10.1126/sciadv.1700324

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