

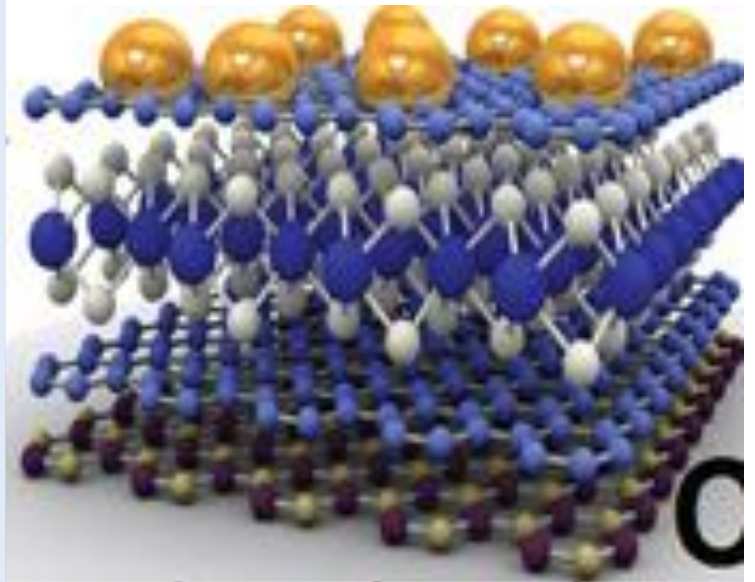
Materials: One plus one is greater than two Combining graphene with monolayers of transition metal dichalcogenides (TMDC) can create super efficient solar cells

The team led by Prof Castro Neto, from NUS together with researchers from the University of Manchester had demonstrated multi-layered heterostructures in a three-dimensional stack using graphene with other one-atom thick materials. This breakthrough has opened up a new paradigm in material science, leading to ultrathin and flexible devices, which has the potential to revolutionise a host of diverse applications. For example, photovoltaic cells can be made so thin that solar panels on houses could eventually be created using solar "paint".

The researchers achieved this by combining graphene - world's thinnest, strongest and most conductive material - together with semiconductor materials known as metal dichalcogenides (TMDCs). In the devices, the layers of TMDC were sandwiched in between layers of graphene with each new layer in these stacks carefully selected to add a new functionality to the overall device. This specially tailored structure allowed the researchers to achieve functionality and unique properties which surpasses any of the individual materials.

TMDC films have been traditionally been used as solid state lubricants and industrial surface protection, but they have a large optical absorption range and is able to absorb light energy well. By coupling TMDCs as good photoactive materials with optically transparent graphene as a good transparent electrode, extremely sensitive and efficient photovoltaic devices could be created which potentially can be used as ultrasensitive photodetectors or super efficient solar cells. The layered nature of these structures and the exceptional mechanical strength provided by the graphene and TMDC crystals also means that the devices created are highly flexible and able to withstand a large degree of bending. Solar cells made using this newly developed technique can be made 150 times thinner and 15 times more sensitive than the typical ones today which use silicon, a less sensitive semiconductor which needs to be made much thicker.

The outcome of the research has been published in **Science**. The researchers will be looking at ways to synthesize the new materials on a much larger scale so that prototypes can be developed to test out the devices on actual use conditions.



Schematic representation of hBN/Gr/MoS₂/Gr (layers bottom to top) photovoltaic device with gold nanoparticles spattered on top of the top graphene layer.
[Image source: Science]