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TECHNOLOGY UPDATE

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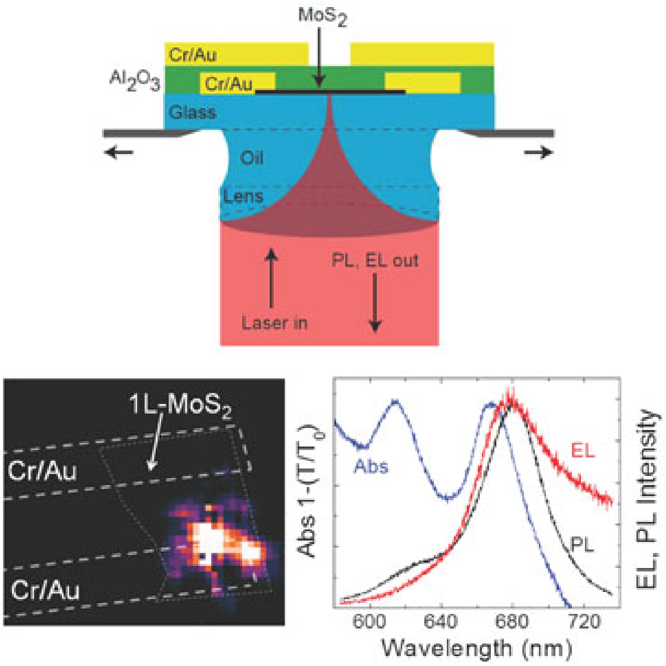
First light for MoS2

Single-layer molybdenite (MoS_2) transistors can emit light, according to new work by researchers in the UK, US and Germany. The new result confirms that it is possible to build light sources and other photonic elements from layered 2D semiconductors such as MoS_2 for future optoelectronics applications.



(http://images.iop.org/objects/ntw/news/12/4/15/image1.jpg)

The sample and experiment results (http://images.iop.org/objects/ntw/news/12/4/15/image1.jpg)

Made of molybdenum and sulphur, single-layer MoS_2 is a semiconductor with a direct bandgap (of 1.8 eV), which means that it might be better than indirect bandgap silicon for making certain photonic devices. Indeed, some scientists are also starting to believe that it could even rival "wonder material" graphene (which does not have a bandgap at all in its pristine state) for use in future electronic circuits. A direct bandgap is important when it comes to making devices like LEDs, solar cells and photodetectors, and any other photonic devices that exploit electron-hole pair excitation, because devices made with direct rather than indirect gap semiconductors are more efficient. Having a bandgap also means that a device can be more easily switched on and off – an important prerequisite for transistors, for example.

The material also appears to have good charge mobilities of greater than 100 cm^2/Vs – and perhaps even up to 500 cm^2/Vs – values that compare well to state-of-the-art silicon. And because it is a van der Waals solid (made up of 2D sheets that are weakly bonded to each other), it is compatible with a variety of substrates – even transparent or plastic ones. Finally, single-layer molybdenite is only about 0.65 nm thick, which means that very thin transistors can be made from it. Such devices would dissipate heat differently than conventional transistors made from silicon.

Now, a team of researchers led by Phaedon Avouris and Mathias Steiner of IBM's TJ Watson Research Center in Yorktown Heights have seen that 2D MoS_2 emits light when excited with an electrical current. Such bandgap-related light emission in 2D semiconductors is one of the most important and intensely researched topics in nanoscale science and technology, says Steiner, and our result confirms that it is possible to build light sources and other photonic elements from 2D semiconductors such as MoS_2.

Visible light emission

The team, which includes scientists Andrea Ferrari from the University of Cambridge in the UK and Ralph Krupke at the Karlsruhe Institute of Technology in Germany, obtained its results by passing an electrical current through a transistor containing single-layer MoS_2 as the channel material. "By then using an optical microscope, we were able to detect light emission in the visible spectral range through the transparent substrate underneath the transistor," said Steiner.

There is still much work to do, however, before real-world MoS_2 optoelectronics become truly competitive with silicon, he adds. This is because the efficiency of the light emitted from the material is still relatively low. "Future research needs to address device design and explore novel gating techniques to improve light emission yields and better control charge carrier injection and extraction," team member Ravi Shankar Sundaram told *nanotechweb.org*. "This might be done by using highly efficient gates to create electrostatic p-n junctions in the MoS_2 channel, or by strongly doping the material with polymer electrolytes, for example."

The current work is detailed in *Nano Letters*.

About the author

Belle Dumé is contributing editor at *nanotechweb.org*.