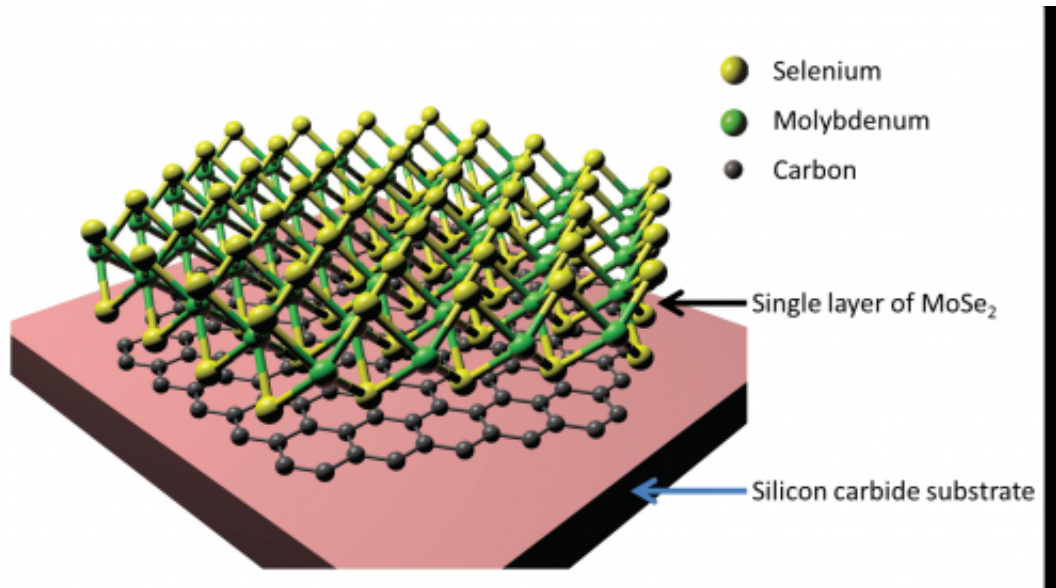


Scientists cook up new electronic material

January 10 2014, by Glenda Chui



This diagram shows a single layer of MoSe₂ thin film (green and yellow balls) grown on a layer of graphene (black balls) that has formed on the surface of a silicon carbide substrate. Scientists who made the material and measured details of its electronic structure discovered it's a natural fit for making thin, flexible light-based electronics. Credit: Yi Zhang/Stanford Institute for Materials and Energy Sciences and Advanced Light Source, Berkeley Lab

(Phys.org) —Scientists from SLAC, Stanford and Berkeley Lab grew sheets of an exotic material in a single atomic layer and measured its electronic structure for the first time. They discovered it's a natural fit for making thin, flexible light-based electronics.

In a study published Dec. 22 in *Nature Nanotechnology*, the researchers

give a recipe for making the thinnest possible sheets of the material, called molybdenum diselenide or MoSe_2 , in a precisely controlled way, using a technique that's common in electronics manufacturing.

"We found the right recipe, and we provide it in the paper so people can develop it more for industrial purposes," said Sung-Kwan Mo, a beam scientist at Lawrence Berkeley National Laboratory's Advanced Light Source (ALS), where the material was made.

"Based on tests at the ALS and at Stanford, now we can say MoSe_2 has possible applications in photoelectronic devices, such as light detectors and solar cells," said Yi Zhang, a postdoctoral researcher who designed and built the equipment used to make the thin sheets, and the report's first author. The material also has potential for novel types of electronics that are still in the future, he said. Zhang is affiliated with Berkeley Lab and the Stanford Institute for Materials and Energy Sciences, which is jointly run with SLAC National Accelerator Laboratory.

Single atomic sheets of MoSe_2 have been generating a lot of scientific interest lately because they belong to a small class of materials that absorb light and glow with great efficiency.

But until now, no one had been able to make extremely thin layers of MoSe_2 in significant quantities and directly observe the evolution of their [electronic structure](#). This is important because a material's electronic behavior can change fundamentally, and in useful ways, when its electrons are confined to such thin layers.

To make the sheets, researchers heated molybdenum and selenium in a vacuum chamber at the ALS until they evaporated. The two elements combined and were deposited as a thin, high-quality film. By tweaking the process, known as [molecular beam epitaxy](#), the scientists were able to grow films that were one to eight atomic layers thick.

The team probed the electronic structure of the film with the ALS's powerful X-ray beam, and later with equipment at Stanford. They found the first direct experimental evidence that the material abruptly changes electronic structure, becoming a much more efficient absorber and emitter of visible light, when made in sheets that are atomically thin.

The team also discovered that electrons with different spins – described as either "up" or "down" – travel along different paths and in opposite directions through the hexagonal structure of single-layer MoSe₂. This could prove useful in "spintronics," a next-generation technology that would use the spins of electrons, rather than their charge, to carry and store information, said Yongtao Cui, a Stanford postdoctoral researcher who was involved in testing the film.

MoSe₂'s novel structure may also lend itself to an even newer concept called "valleytronics," in which both spin and charge are used to transport and store information. This idea surfaced in 2002; like spintronics, it's being eagerly explored as a potential way to continue the trend toward smaller, faster, cheaper electronic devices.

"This field is still in the initial stage of development," Cui said. "People have these applications in mind, but as research goes along they may discover new aspects of these materials, and possibly new applications."

More information: "Direct observation of the transition from indirect to direct bandgap in atomically thin epitaxial MoSe₂." Yi Zhang, Tay-Rong Chang, Bo Zhou, et al. *Nature Nanotechnology* (2013) [DOI: 10.1038/nnano.2013.277](https://doi.org/10.1038/nnano.2013.277)

Provided by SLAC National Accelerator Laboratory

Citation: Scientists cook up new electronic material (2014, January 10) retrieved 16 April 2024 from <https://phys.org/news/2014-01-scientists-cook-electronic-material.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.