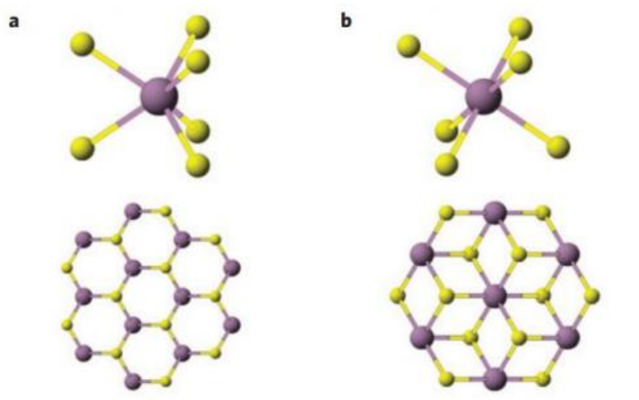
Researchers find a way to reduce contact resistance with molybdenum disulphide nanosheets

5 September 2014, by Bob Yirka



Crystal structures of the 2H and 1T phases, respectively. In the upper diagram, trigonal prismatic (a) and octahedral (b) coordinations are shown. The lower panel shows the c-axis view of single-layer TMD with trigonal prismatic (a) and octahedral (b) coordinations. Atom colour code: purple, metal; yellow, chalcogen. Credit: *Nature Materials* (2014) doi:10.1038/nmat4080

(Phys.org) —A team of researchers with members from Rutgers University and Los Alamos National Laboratory has found a way to get around the problem of metals forming high-resistance when deposited on 2H phase molybdenum disulphide (MoS_2). In their paper published in the journal *Nature Materials*, the team describes how they came up with a process for inducing ^{2}H phase nanosheets to the metallic 1T phase, thereby reducing contact resistance.

While carbon nanotubes have dominated the headlines in the search for the basis of the next generation of computer chips, scientists have been making inroads using other materials as well—one in particular, MoS_2, has shown promise. It's actually been used to create working electronic devices. Unfortunately, its use in mass producible devices has been limited by the same constraint as that found with carbon nanotubes—the resistance that occurs when attempting to connect the semiconductor to other electronics. The problem comes about because the sheets are so thin, attempting to attach wires has been problematic and research into doping methods has not gone well. In this new effort, the researchers have found a way to change the phase of a sheet of MoS2 from a semiconductor, to metallic, i.e. a fully conducting contact.

The idea is that if a tiny section of a MoS_2 sheet can be phase shifted to a metallic state, then wires could very easily be connected to it, and that's exactly what they team has done—they developed a process they call lithiation which modifies the MoS_2 to the metallic phase, by exposing the material to n-butyl lithium. To make sure it really works, they successfully built several field effect transistors using the modified sheets.

There are still some problems however, the team is having trouble finding a way to accurately phase shift just the part of a sheet they're after, and because MoS_2 is metastable, it tends to shift back to its purely semiconductor phase under certain conditions, and the researchers aren't sure just yet what exactly those conditions are. The team is working on these issues, of course—one possible solution may be in producing MoS_2 differently—creating flakes using exfoliation, perhaps or chemical vapor deposition.

More information: Phase-engineered low-resistance contacts for ultrathin MoS2 transistors, *Nature Materials* (2014) DOI: 10.1038/nmat4080

Abstract
Ultrathin molybdenum disulphide (MoS2) has emerged as an interesting layered semiconductor

because of its finite energy bandgap and the absence of dangling bonds. However, metals deposited on the semiconducting 2H phase usually form high-resistance (0.7 k? ?m–10 k? ?m) contacts, leading to Schottky-limited transport. In this study, we demonstrate that the metallic 1T phase of MoS2 can be locally induced on semiconducting 2H phase nanosheets, thus decreasing contact resistances to 200–300 ? ?m at zero gate bias. Field-effect transistors (FETs) with 1T phase electrodes fabricated and tested in air exhibit mobility values of ~50 cm2 V?1 s?1, subthreshold swing values below 100 mV per decade, on/off ratios of >107, drive currents approaching ~100 ?A ?m?1, and excellent current saturation. The deposition of different metals has limited influence on the FET performance, suggesting that the 1T/2H interface controls carrier injection into the channel. An increased reproducibility of the electrical characteristics is also obtained with our strategy based on phase engineering of ?MoS2.

APA citation: Researchers find a way to reduce contact resistance with molybdenum disulphide nanosheets (2014, September 5) retrieved 12 November 2019 from
https://phys.org/news/2014-09-contact-resistance-molybdenum-disulphide-nanosheets.html