Scientists unlock the properties of new 2-D material

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A new two-dimensional material has become a reality, thanks to a team of Danish and Italian scientists.

The research, led by physicists at Aarhus University, succeeded in the first experimental realisation and structural investigation of single-layer vanadium disulphide (VS_2). It is published today in the journal *2-D Materials*.

VS_2 is one of a diverse group of compounds known as transition metal dichalcogenides (TMDs). Many of these can assume a layered crystal structure from which atomically thin crystalline sheets can be isolated. The electronic properties of the single-atomic-layer crystals can differ in important ways from those of the layered bulk crystals.

Lead author Dr. Charlotte Sanders of Aarhus University explained the importance of the new findings: "Theoretical studies suggest that single-layer VS_2 might exhibit very interesting physics, including magnetism and strong correlations. It might also host charge density wave states, as does bulk VS_2. However, making VS2 is difficult and the single layer has not been successfully made before now.

"In fact, magnetism in single-layer materials has only recently been observed, and is still quite rare. So, the possibility that this material might be magnetic is exciting."

To make the single layer of VS_2, the researchers evaporated vanadium

onto a clean gold surface at room temperature. They then heated the sample in the presence of sulphur-containing molecules that react with the vanadium to produce the VS_2. The team measured the properties of the samples using low-energy electron diffraction, scanning tunnelling microscopy, and X-ray photoelectron spectroscopy.

Significantly, the team also discovered a new and unpredicted vanadium sulphide compound. Most 2-D materials can, in theory (although not necessarily in practice), be derived from bulk layered crystals. However, there is no 3-D material that has similar stoichiometry and crystal structure to those of the new compound, which is formed when single-layer VS_2 is depleted of sulphur by heating.

In consideration of the likely magnetic properties of related vanadium compounds, the new material might be another candidate for two-dimensional magnetism.

"The new material's electronic structure, along with possible charge density wave phases and magnetic ordering, remain to be explored, and an interesting open question is how its properties differ from those of stoichiometric single-layer VS_2," said Dr. Sanders.

More information: "Novel single-layer vanadium sulphide phases" Arnold et al 2018 *2D Mater*. 8 045009, DOI: 10.1088/2053-1583/aad0c8

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