Scientists explore quantum properties in the two-dimensional limit

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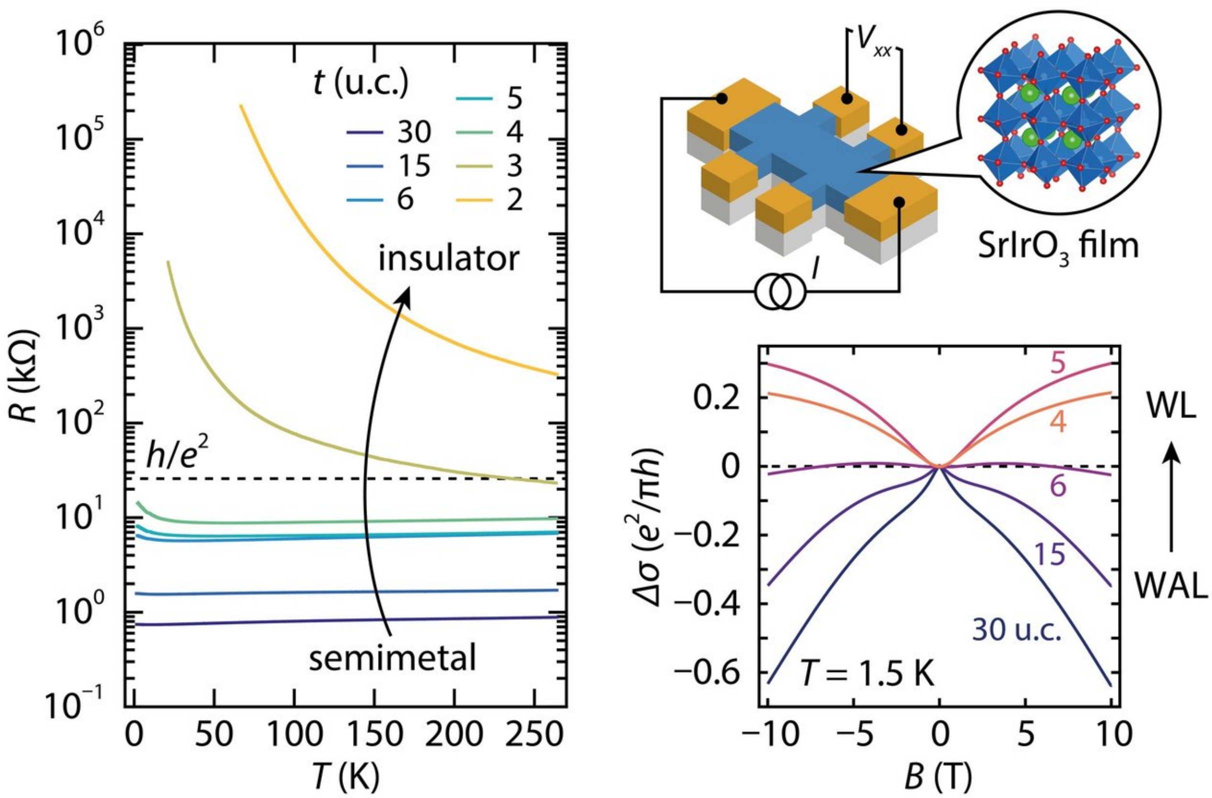

Credit: TU Delft/Dirk Groenendijk

As electronic components become smaller, understanding how materials behave at the nanoscale is crucial for the development of next-generation electronics. Unfortunately, it is very difficult to predict what happens when materials are only a few atomic layers thick. To improve our understanding of the so-called quantum properties of materials, scientists at the TU Delft investigated thin slices of $SrIrO_3$, a material that belongs to the family of complex oxides. Their findings have recently been published *Physical Review Letters*.

The researchers synthesized the material using pulsed laser deposition (PLD), a method for depositing single crystal films with atomic layer precision. "We studied crystals with thicknesses down to 2 atomic layers (0.8 nanometres)," said lead author Dirk Groenendijk, who is a Ph.D. candidate at TU Delft.

Electrons can normally move freely in the material, and $SrIrO_3$ shows metallic behaviour. However, the scientists found that at a thickness of 4 layers, there appears to be a turning point. Below this thickness, the electrons become localized and the material transitions to an insulating state. At the same time, the material orders magnetically and the effects of spin-orbit coupling are strongly enhanced. This last property is of interest for the development of new magnetic memory devices, because the spin of the electron can be used to store and transfer information.

The next generation of electronic devices will require further miniaturization of their components, and it will not be long before chip manufacturers go below 10 nanometres. "At this scale, you can count the number of atoms, and you enter the realm of quantum mechanics," says Groenendijk. For future devices, researchers are also looking for new materials with currently inaccessible functionalities. In this respect, complex oxides are promising candidates that display a wide variety of exotic phenomena. The research of Groenendijk and colleagues constitutes an important step towards the understanding of their quantum properties in the two-dimensional limit.

More information: D.J. Groenendijk et al., Spin-Orbit Semimetal $SrIrO_3$ in the Two-Dimensional Limit, *Physical Review Letters* (2017).

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