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Diameter-dependent critical temperature of superconductivity in individual WS_2 nanotubes

Superconductivity in low dimensional Transition Metal Dichalcogenides (TMD) materials has been attracting significant attention in recent years. Among them, the TMD nanotube is a fascinating platform for researching superconductivity because of its unique dimensionality and geometry. A natural question raised here is that how the superconductivity is affected by bending the lattice of the material.

Here we report the first observation of superconductivity in an individual multi-walled nanotube made of tungsten disulfide (WS_2) [1], realized by electrochemical doping via the liquid gating technique as shown in Figure 1. We conclude that the critical temperature of superconductivity decreases with shrinking the nanotube diameter, and displays an unexpected linear behavior as a function of the inverse diameter, i.e. the curvature of the nanotube [2]. Remarkably, this result comes as a surprise that in the past people had believed an increasing of the critical temperature by narrowing the diameter of carbon nanotube, due to the increasing of electron-phonon coupling. In addition, we find that the chirality of the nanotube also affects the superconducting state [1], and the chiral signal displays an unprecedented quantum oscillation in conjunction with the Little-Parks effect.

The present results are an important step in understanding the microscopic mechanism of superconductivity in a nanotube, opening up a new way of superconductivity in crystalline nanostructures.

References

[1] F. Qin *et al.*, *Nature Communications* **8**, 14465 (2017).
[2] F. Qin *et al.*, *Nano Letters* **18**, 6789-6794 (2018).

Figures

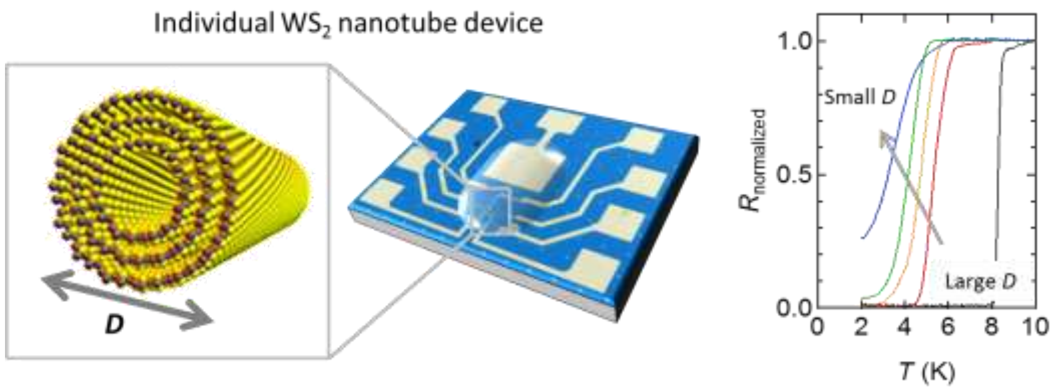

Figure 1: Schematic figure of liquid gating device and the diameter-dependent superconducting properties in individual WS_2 nanotubes.