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Title of the Presentation: Electric-Field-Induced Metal-Insulator Transition and Quantum Transport in Large-Area Polycrystalline MoS2 Monolayers

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Short Biography:

Mr. Ou is a doctoral student of the Department of Applied Physics of Nagoya University, Japan. He received B.E. and M.E. degrees from Huazhong University of Science and Technology, China. His research interest includes the transport and optical properties of two-dimensional TMDC and heterostructures. He is now a fellow of THERS Interdisciplinary Frontier Next Generation Researcher.

Abstract:

As one of the most well-known two-dimensional semiconductor, monolayer MoS_2 have been intensively studied, showing the emergence of metal-insulator transition (MIT), superconductivity [1] and quantum conduction [2], which enables the material not only a potential candidate for future electronic applications, but also an ideal platform for studying two-dimensional electronic systems. However, most studies use single-crystal flakes, which hindered the further functionalities of the material. On the contrast, transistors made of large-area polycrystalline monolayers have been reported [3], while there has been no systematic study on the transport behaviors of the material. Here, we report on the observation of MIT and quantum correction to transport properties in polycrystalline MoS_2 monolayer transistors.

We fabricated electric double-layer transistors (EDLTs) using CVD-grown polycrystalline MoS_2 (Fig. 1a). Electrostatic doping of MoS_2 is introduced by the ion redistribution inside electrolyte, which serves a liquid gate. Because of the electric-induced high carrier density, the polycrystalline MoS_2 readily shows MIT at a relatively low driving voltage (Fig. 1b). Moreover, Hall effect measurement reveals a high mobility of $> 100\ \mathrm{cm^2\ V^{-1}\ s^{-1}}$. The low-temperature magnetotransport presents a crossover between weak localization and weak antilocalization (Fig. 1c). The above results indicate that with sufficiently high carrier density, the negative effect of grain boundary in polycrystalline MoS2 could be greatly suppressed, to enable the intrinsic transport and quantum conduction. This study reveals that polycrystalline MoS2 monolayers have significant potential for the large-area electronic applications.

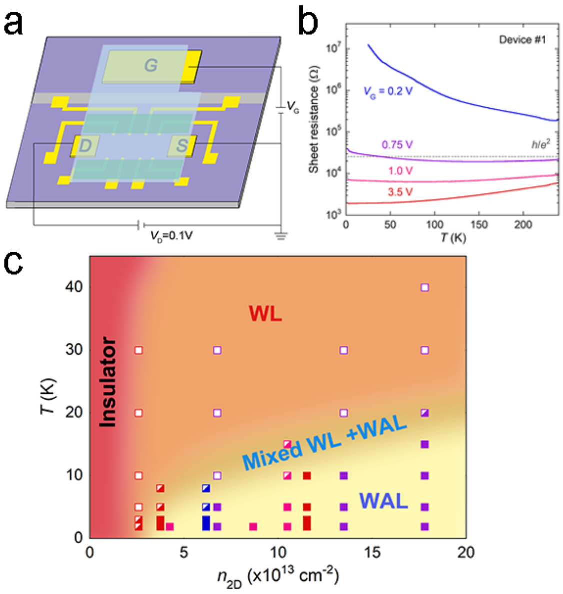

Fig. 1. a) Device structure of fabricated EDLT. b) Temperature-dependent sheet resistance as a function of gate voltage V_G. c) Low-temperature phase diagram against carrier density.

[1]J. Ye et al., Science 338, 1193-1196 (2012).
[2]Y. Schmidt et al., Phys. Rev. Lett. 116, 046803 (2016).
[3]N. Li et al., Nat. Electron. 3, 711-717 (2020).