Quantum Hall Effect in Two-Dimensional Electron Gas of Bi_2O_2Se

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Bi_2O_2Se, a layered oxide similar to Van der Waals 2D materials, has been recognized for its high mobility for several years [1]. Our findings mark a significant milestone by showing that the Quantum Hall effect can be achieved in this system, positioning Bi_2O_2Se as a new platform for quantum transport. The realization of two-dimensional electron systems (2DES) heavily relies on dedicated heterostructure growths. In this work, we report the integer quantum Hall effect in Bi_2O_2Se, a representative member of a more accessible oxide family. This new oxide platform exhibits characteristic advantages in structural flexibility due to its layered nature, making it suitable for scalable chemical vapor deposition (CVD) growth. In thin films of Bi_2O_2Se, a single or few sub-band 2DES behaves as simple quantum wells. The film thickness acts as the sole design parameter, with the sub-band occupation determined by the electric field effect. High-quality 2DES enables clear observation of quantized edge states down to the quantum limit, where only one Landau level of a single sub-band remains filled. The widely accessible CVD growth, structural flexibility as layered compounds, and unique small mass distinguish Bi_2O_2Se from other high-mobility oxides, therefore, providing a new platform for exploring quantum Hall physics in oxide materials.

[1] J. Wu *et. al.* High electron mobility and quantum oscillations in non-encapsulated ultrathin semiconducting Bi_2O_2Se. *Nat. Nanotechnol.* **12**, 530–534 (2017).