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Crystalline anisotropic curtaining effect in Bismuth

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Elemental bismuth is a semi-metallic material with inherently strong spin-orbit coupling and high carrier mobility. These unique electronic properties makes it highly important for both fundamental researches and future applications[1]. Motivated by the recent development on higher-order topological insulator phase in Bismuth[2], it is desirably needed to explore the possibility of artificially writing topological conduction channel using focused-ion beam (FIB) technique. However, due to its low crystallization temperature, the local heating by ion beam assists the growth of Bismuth nanowires along the beam direction and therefore leads to strong curtaining effect on the polished surface, which is a major challenge for microstructure fabrication. On the other hand, we found that this curtaining effect is highly anisotropic due to the preferential growth of bismuth nanowires along different crystalline directions. By changing the ion beam direction from trigonal to bisectrix direction, the curtaining effect is strongly suppressed and therefore a clean lamella can be obtained. This sets the basis for the future development of FIB-printed topological microcircuits. Moreover, the nanowire growth along bisectrix direction sheds the light on an interesting method to develop integrated bismuth nanowire array, the pattern of which can be exactly controlled by the ion beam condition.

[1] Asish K. Kundu et al., *Quantum size effects, multiple Dirac cones and edge states in ultrathin Bi(110) films*; arXiv: 2106.13943 **(2021)**.

[2] Frank Schindler, Zhijun Wang et al., *Higher-Order Topology in Bismuth*; Nature Physics 14 **(2018)**, 918.

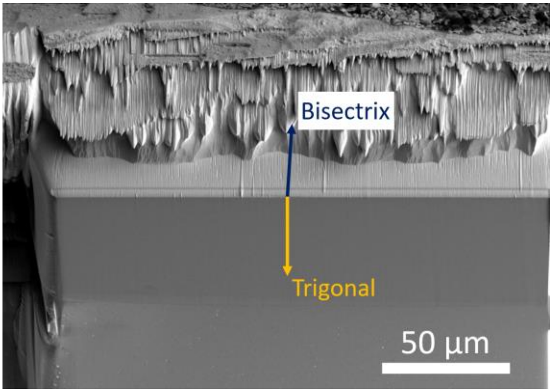

Fig. 1: Crystalline anisotropic curtaining effect in Bismuth.