論文題目要旨

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論文題目: **Experimental and theoretical studies on bismuth thin films on semiconductor substrates** (半導体基板上のビスマス薄膜に関する実験的および理論的研究)

論文要旨: This dissertation presents experimental and theoretical studies on the electronic structure of monolayer (ML) to bilayer (BL) of heavy semi-metal Bismuth (Bi) with strong spin-orbit coupling (SOC) effects grown on a suitable lattice match (0.08%) [**1**] substrates noted as indium antimonide (InSb). I demonstrate that the substrate influences the electronic structure of the Bi thin films, resulting in thickness-dependent quantum well states (QWS) by the phase accumulation model (PAM) [**2, 3**]. As a result, I observed a new state in the ultrathin case of less than 2BL as predicted by the theoretical band structure [**4**]. The Bi thickness was confirmed by the energy and momentum distribution curve followed by the PAM. In the higher BL case, almost all previous results [**2, 3, 4**], such as QWS, surface state, electron, and hole pocket were observed, but no clear evidence was found for down to 1BL. However, I could clearly observe the evidence of the 1ML(0.5BL) thickness and measured the electronic structure. I also found the QWS at the thickness of 1.25BL and analyzed it using the PAM. This could explain why Bi (111) on InSb has higher conductivity than free-standing Bi (111) and solves the long-debated problem of semi-metal to semiconductor transition [**6, 7**] in the bulk case and gives a solution of semi-metal to metal transition in the ultrathin case. Therefore, higher conductivity with SOC is a key factor for the quantum spin hall effect, where SOC acts as an external magnetic field, which is the key for next-generation quantum computers [**8**]. These findings contribute to the fundamental understanding of the origin of the electronic behavior of metal/semiconductor interaction and offer a foundation for future research aimed at exploring the behavior of thin films and their potential applications in advanced electronic devices [**9**].

Reference

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