TF3-004

MBE growth of topological insulator Bi_2Se_3 films on Si(111) substrate

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We will report atomically sharp epitaxial growth of Bi_2Se_3 three-dimensional topological insulator films on Si(111) substrate with molecular beam epitaxy (MBE). It was achieved by employing two step growth temperatures to prevent any formation of second phase, like as $SiSe_2$ clusters, between Bi_2Se_3 and Si substrate at the early stage of growth. The growth rate was determined completely by Bi flux and the Bi:Se flux ratio was kept ∼1:15. The second-phase-free atomically sharp interface was verified by RHEED, TEM and XRD. Based on the RHEED analysis, the lattice constant of Bi_2Se_3 relaxed to its bulk value during the first quintuple layer implying the absence of strain from the substrate. Single-crystalline XRD peaks of Bi_2Se_3 were observed in films as thin as 4 QL. TEM shows full epitaxial structure of Bi_2Se_3 film down to the first quintuple layer without any second phases. This growth method was used to grow high quality epitaxial Bi_2Se_3 films from 3 QL to 3600 QL. The magneto-transport properties of these thin films show a robust 2D surface state which is thickness independent.

Keywords: Topological Insulator, Bi_2Se_3, MBE