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Epitaxial Bi_2Se_3 films on Si (111) with atomically sharp interface

ELIAV EDREY, YONG SEUNG KIM, NAMRATA BANSAL, YOICHI HORIBE, SEONGSHIK OH, Rutgers University, OH GROUP TEAM — Atomically sharp epitaxial growth of Bi_2Se_3 films has been achieved on Si (111) substrate with MBE. The growth was self-limited; that is, growth rate was determined completely by Bi flux with excess Se species around. The Bi:Se flux ratio, measured by QCM, was kept ∼1:15. Two step growth temperatures were a key to achieving second-phase-free high quality Bi_2Se_3 films on Si substrates. With single-step high temperature growth, second phase, presumably $SiSe_2$ clusters, was formed at the early stage of growth. On the other hand, with low temperature growth, crystalline quality of the films was poor even if second phase was absent. With low temperature initial growth followed by high temperature growth, second-phase-free atomically sharp interface was obtained between Bi_2Se_3 and Si substrate, as verified by RHEED, TEM and XRD. The lattice constant of Bi_2Se_3 relaxed to its bulk value during the first quintuple layer based on the RHEED analysis, 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_3film 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.

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