Altermagnetic MnTe Epilayers Grown by Molecular Beam Epitaxy on Matched and Mismatched (111) Substrates

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Manganese telluride (MnTe) has recently emerged as a prominent altermagnetic candidate, exhibiting a large momentum-dependent spin splitting in its electronic band structure while maintaining almost zero net magnetization [1]. Its thin-film form is of particular interest for spintronic applications due to its compatibility with existing electronic device platforms. Consequently, investigating the epitaxial growth of MnTe on different substrates, especially those widely used in industry, is of significant importance. In this work, we report the growth of high-quality MnTe epilayers in the hexagonal nickel ar senide phase on (111)-oriented InP, SrF_2, BaF_2, and Si substrates by molecular beam epitaxy. The growth process was monitored *in situ* by reflection high-energy electron diffraction, which confirmed two-dimensional epitaxial growth with well-defined streaky patterns at the final growth stage. Atomic force microscopy further revealed atomically smooth film surface. Notably, epitaxial growth on Si(111) was achieved for film thicknesses as low as 30nm, highlighting the potential of MnTe for integration with well-established silicon based semiconductor technology. X-ray diffraction and transmission electron microscopy reveal highly (0001)-oriented epitaxial growth and confirm the hexagonal NiAs-type structure of MnTe on all substrates. Substrate-dependent strain arising from lattice and thermal expansion mismatch is observed. For MnTe films grown on SrF_2(111) and BaF_2(111), which exhibit minimal thermal expansion mismatch, the determined lattice constants (a =0.414 nm and c = 0.671 nm) are consistent with the values reported for bulk MnTe crystals [2]. The observed c/a ratio between 1.60 and 1.62 for all substrates used. SEM-EDX analysis revealed an excess of Mn, characteristic of MnTe films [3], with a Mn concentration of approximately 53 ± 2.5 at.% for all samples, despite a high Te/Mn flux ratio of 2.3 during growth. Magnetotransport measurements exhibit Dzyaloshinskii-Moriya induced signatures of weak ferromagnetism, manifested as hysteresis in magnetoresistance curves. Our results establish a reliable route for the epitaxial growth of NiAs-type MnTe thin films on technologically relevant substrates.

References:

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