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Electrical Transport in Bi2Te3 Thin Film Devices: Effective Band Structure, Charge Carrier Distribution and Josephson Coupling MARTIN STEHNO, MESA+ Institute for Nanotechnology, University of Twente, PROSPER NGABONZIZA, Max Planck Institute for Solid State Research, HIROAKI MYOREN, Faculty of Engineering, Saitama University, ALEXANDER BRINKMAN, MESA+ Institute for Nanotechnology, University of Twente — Engineering of topological states in Josephson junctions requires understanding of the effective band structure of the topological insulator (TI) material that forms the weak link. Previous work has focused on optimizing materials aspects to boost the effective Josephson coupling while providing little insight into underlying mechanisms. We present transport measurements on back-gated Bi_2Te_3 thin film devices with low levels of bulk doping. Carrier densities are obtained from a two-carrier model fit to the Hall effect data. To validate the fits, we calculate the band structure of a thin film using a tight-binding model and find excellent agreement in the number of transport carriers. We conclude that the bottom region of the film changes from a deep quantum well to a depletion zone as the back-gate voltage is lowered, which explains a change in the observed weak-antilocalization signal with gate bias. For our Nb/Bi_2Te_3/Nb Josephson junctions, we observe that the Josephson coupling energy scales according to the theory of long diffusive SNS contacts with a smaller, effective value for the Thouless energy of the weak link that takes into account the longer dwell time in the junction area due to interface barriers and the conductivity mismatch between the materials.

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