Growth and characterization of molecular beam epitaxial Bi$_2$Se$_3$ films and heterostructures$^1$ ZHIYI CHEN, THOR GARCIA, JOEL JESUS, LUKAS ZHAO, HAIMING DENG, JEFF SECOR, MILAN BEGLIARBEKOV, LIA KRUSIN-ELBAUM, MARIA TAMARGO, The City College of New York — Significant bulk conduction in the bulk of topological insulators (TIs) has been a major challenge in the studies of the their spin-helical Dirac surface conduction channels, a problem particularly severe in charge transport. Growth of high quality low-carrier concentration TI films is crucial not only for the fundamental study of TIs, but also for manufacture of heterostructures and devices. Here we report our results on synthesis and characterization of high-quality Bi$_2$Se$_3$ films grown using molecular beam epitaxy (MBE). A superior surface topography (smoothness) of the MBE Bi$_2$Se$_3$ films was obtained by a suitable choice of buffer layers used. A precise control of layer thickness was achieved and layers with good uniformity and surface quality were obtained. Hall measurements showed the films to be $n$-type, with sheet carrier concentrations typically in the $6 \times 10^{12}$ cm$^{-2}$ range. Using optimal growth conditions for the best quality Bi$_2$Se$_3$ films, magnetically doped Bi$_2$Se$_3$ and heterostructures such as Bi$_2$Se$_3$/ZnSe were also grown and characterized in transport and with optical measurements. Novel magnetically ordered insulating state induced by magnetic doping, and exotic effects at the interfaces will be presented.

$^1$Supported by NSF-DMR-1122594 and DOD-W911NF-13-1-0159

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Date submitted: 15 Nov 2013

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