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An abrupt change in transport dynamics across the topological phase transition in the $(Bi_{1-x}In_x)_2Se_3$ and ultra-thin $Bi2_2Se_3$ systems LIANG WU, ROLANDO VALDES AGUILAR, ANDREAS V. STIER, LUCAS S. BILBRO, YUVAL LUBASHEVSKY, N. PETER ARMITAGE, The Institute for Quantum Matter, Department of Physics and Astronomy, The Johns Hopkins University, Baltimore, MD 21218 USA, MATTHEW BRAHLEK, NAMRATA BANSAL, SEAN OH, Department of Physics and Astronomy, Rutgers the State University of New Jersey. Piscataway, NJ 08854 — We have utilized time-domain terahertz (THz) spectroscopy to investigate the low frequency optical conductivity in $(Bi_{1-x}In_x)_2Se_3$ through its topological phase transition from the pure ($x = 0$) compound to the topologically trivial strongly insulating material ($x > 0.25$). The thickness independent Drude peak shows only minor broadening at low In substitutions. However, above $x \sim 0.05$ we observe a sudden collapse in the transport lifetime. This substitution level closely coincides with a maximum in the mid-infrared (MIR) absorption coefficient which can be identified with the substitution level where the band gap closes, the band structure inverts, and hence the topological class changes. We therefore associate the collapse in the transport lifetime with the loss of topological protection of surface states as the system enters the topologically trivial phase. Topological phase transition driven by reducing film thickness is also investigated. Similar collapse in the transport lifetime is observed in the ultra-thin limit.

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