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Cyclotron resonance of surface states in the bulk-insulating topological insulator Bi_2Se_3 by THz spectroscopy LIANG WU, The Johns Hopkins University, WANG-KONG TSE, Los Alamos National Laboratory, CHRISTOPHER MORRIS, The Johns Hopkins University, MATTHEW BRAHLEK, NIKESH KOIRALA, SEONGSHIK OH, Rutgers the State University of New Jersey, PETER ARMITAGE, The Johns Hopkins University, THE JOHNS HOPKINS UNIVERSITY TEAM, LOS ALAMOS NATIONAL LABORATORY TEAM, RUTGERS THE STATE UNIVERSITY OF NEW JERSEY TEAM — We have utilized magneto-optical time-domain terahertz spectroscopy to investigate the low frequency optical response of topological insulator films of $Cu_xBi_2Se_3$ and Bi_2Se_3. Such experiments give sufficient information to measure the mobility and density of multiple conduction channels simultaneously. Sharp cyclotron resonances (CRs) were observed in both samples by Faraday rotation experiments. We find that the $Cu_xBi_2Se_3$ films with certain Cu concentration are bulk insulators with only surface conduction channels. This is consistent with pure topological surface states conduction and an E_F that is $\sim$150 meV above Dirac point (around 70meV below conduction band minimum). Hence, a true topological insulator with insulating bulk is realized. In contrast, we find that Bi_2Se_3 with E_F $\sim$350 meV above Dirac point has two channels; a dominant one that exhibits a CR in the Faraday rotation comes from surface states and a second channel which does not show a CR comes from bulk and/or 2DEG. Orbital effect on the electrodynamics of surface states and electron-phonon interaction are also discussed.

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