Pressure Turns Semiconductor into New State of Matter

Scientific Achievement

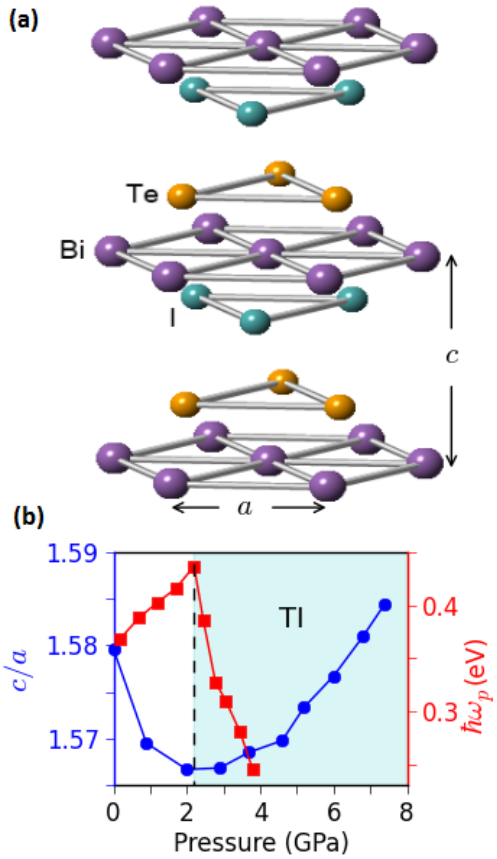
Used pressure to transform a semiconductor into a "topological insulator" (TI), a state of matter in which a material's interior insulates but its edges or surfaces conduct

Significance and Impact

First case of a pressure-induced TI; results could help scientists find an ideal TI for future electronics applications

Research Details

- Semiconductor is BiTeI, a compound of bismuth, tellurium & iodine
- Pressure was applied up to 10 gigapascals (GPa) with the structural and electronic changes tracked via x-ray powder diffraction (XRD) and infrared (IR) spectroscopy, which reveal that the TI phase occurs between 2 and 8 GPa
- Both data sets show key features between 2 and 3 GPa that are expected to show up during the transition: respectively, a specific change to the BiTeI crystal unit cell and a maximum in the "plasma frequency," a quantity closely related to the material's electronic structure



(a) The crystal structure of BiTeI, with unit cell lengths *a* and *c* (b) Pressure dependence of the ratio *c/a* (circles) from XRD and the plasma frequency ω_p from IR spectroscopy (squares). The minimum in *c/a* and the maximum in ω_p indicate band gap closing and reopening, signaling the transition.

Work was performed at Brookhaven National Laboratory

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