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Electronic transport in silicon doped with sulfur to non-equilibrium concentrations MARK WINKLER, MENG-JU SHER, DANIEL RECHT, MICHAEL AZIZ, ERIC MAZUR, Harvard University — Doping silicon with chalcogens (S, Se, Te) to highly non-equilibrium concentrations ($>10^{20}$cm^{-3}) yields intriguing optical properties, such as near-unity optical absorptance extending to photon energies lower than 0.5 eV — significantly below the band gap of silicon. We have previously hypothesized that this absorption arises due to an impurity band formed from the high concentration of sulfur-dopant states, and could represent one of the first bulk impurity band absorbers. In this talk, we report temperature-dependent Hall effect and resistivity measurements of silicon doped with high sulfur concentrations; doping techniques include both fs-laser doping as well as ion implantation followed by pulsed laser melting and rapid resolidification. We report a sulfur-donor driven transition to metallic conduction, and identify the critical sulfur concentration for this effect. To our knowledge, this is the first report of a metal-insulator transition driven by such a deep state in silicon. We also will discuss the relevance of these findings to our hypothesis that the anomalous sub-band gap absorption represents an impurity-band effect.

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