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Attosecond electronic band gap dynamics.

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High-order harmonics in the extreme ultraviolet (XUV) are used for attosecond transient absorption pump-probe measurements on solid-state materials. In crystalline silicon, an 800 nm, strong-field tunneling process is used to inject electrons into the conduction band, and the silicon 2p L edge absorption to the conduction band is measured at 100 eV photon energies. A 450 attosecond timescale broadening in the conduction band is observed, indicative of a rapid electronic response due to the injection of carriers into the conduction band. On longer timescales, participation of phonons and electron-phonon scattering differences within band valleys are observed. In germanium, both electrons and holes are detected through the 3d electrons of Ge, and hot carrier relaxation of both electrons and holes is measured. In vanadium dioxide, where an insulator to metal transition can take place, both the hot and cold phase are analyzed, revealing a short timescale insulator to metal transition of electronic origin. These will be discussed along with a general view of attosecond measurements in semiconductors and related electronic materials.