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Dynamic compression of semiconductors: deformation potentials to new phenomena[1]

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Semiconductors are central to technological applications, including optoelectronic devices such as solar cells and light emitting diodes. These multilayered devices experience strains up to 1% due to lattice mismatch at different material interfaces; strains as large as 10% are anticipated in future devices based on semiconductor quantum structures. Although large strains are expected to alter properties of operating devices, definite predictions of these changes are difficult due to the inherent limitations of static compression methods. Recent studies at the Institute for Shock Physics have demonstrated that uniaxial strain conditions during dynamic compression can overcome these limitations and reveal important electronic structure changes in semiconductors. Several examples will be presented, including the accurate determination of deformation potentials in GaN and GaP at high strains, the transformation of GaAs from a direct to an indirect gap semiconductor, the different nature of impurities under compression in GaP, and the dramatic reduction of carrier lifetimes in compressed GaAs. In the future, dynamic compression studies are expected to shed light on a range of time-resolved phenomena in bulk and nanoscale materials.

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