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Strength measurements and thermo-mechanical behavior of metals at high-strain rates[1]

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Current state-of-the-art understanding and experimental techniques for investigating the high-strain-rate and themo-mechanical behavior of metals are reviewed. Results for the thermo-mechanical behavior and microstructural characterization of iron and tantalum over a wide range of strain rates are presented. Shear compression specimens (SCS) consisting of rectangular plates into which two slots have been machined at 45° to the loading axis are subjected to high-strain rate deformation using a split Hopkinson (Kolsky) pressure bar. Upon compression of the specimen, the gage section is subjected to a dominant state of shear deformation. *In-situ* temperature measurements are performed in the deforming gage section with a high-speed infrared detector. Microstructural characterization is performed using optical and electron microscopy (SEM, TEM). Orientation imaging microscopy is used to characterize the texture. The results presented include the stress-strain behavior, strength, conversion of plastic work to heat, and microstructural and texture evolution as a function of strain and strain rate. Both iron and tantalum exhibit rate sensitive behavior and the strength of iron approaches that of high strength steels at very high strain rates. The stress-strain response of iron at low strain rates compares well with prior experiments. However, its response at very high strain rates exhibits softening and coincides with that of pre-shocked material. For tantalum, the entire plastic work is converted to heat, while for iron, the fraction of plastic work converted to heat is found to be a function of strain and strain rate. The observed high-strain-rate behavior of both the materials is correlated with microstructural and texture evolution.

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