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Rate and temperature effects on the flow stress and tensile strength of metals

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Some new and obtained earlier experimental data on the elastic precursor decay and rise times of plastic shock waves in several metals and alloys at normal and elevated temperatures are systematized. The data on precursor decay include last measurements at micron and submicron distances where realized shear stresses are comparable with their ultimate ("ideal") values. Results of measurements have been transformed into dependences of plastic strain rate on the shear stress. It has been found the precursor decay may occur in several regimes which are characterized by different decay rates. Anomalous growth of the Hugoniot elastic limit with heating correlates with a fast decay regime and is not observed when the decay is relatively slow. An analysis of the rise times of plastic shock waves shows by order of magnitude faster plastic strain rates at corresponding shear stresses than that at the HEL. Results of measurements of the resistance to high-rate fracture ("spall strength") show gradual increase of the later with increasing rate of tension and approaching the "ideal" strength in a picosecond time range. The spall strength usually decreases with heating although in less degree than the strength at low strain rates does. In general, the temperature dependences of the spall strength do not correlate with dependences of the yield stress that points on larger contribution of the fracture nucleation processes as compared to the void growth. Requirements to constitutive models for high-rate plastic deformation and fracture are formulated on the base of experimental observations.