Virtual Symposium on Experimental Solid Mechanics
July 28th – 29th, 2020, Indian Institute of Science, Bengaluru, India.

Measuring Material Strength and Failure Characteristics at High Strain Rates Using EM Driven Expanding Cylinders

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In this work we use a new methodology to measure the strength of materials at very high strain rates, using magnetically driven expanding cylinder experiments by the means of a pulse current generator (PCG). The expansion of the specimen is done using a "pusher" configuration, enabling one cylinder which carries the magnetic load to push out the external tested material, with negligible effects of the current/magnetic field on it. This allows to test with this technique any material, regardless of its conductivity. We define the yield stress in the tests, using the combination of experimental and numerical analyses. The analysis is conducted at the *forced* stage of acceleration, unlike standard expanding ring/cylinder tests in the literature which use the free flight stage for the strength analysis. This allows to take advantage of the high rate regime, dominated by the fast rise-time of the PCG, and thus to reach very high strain rates, up to 10^5-10^6 sec^{-1}. The failure mechanisms responsible for fragmentation are examined using microscopy, seeking to explore changes in the favorable failure mechanism at different strain rates. The technique is demonstrated for OFHC copper and Tantalum up to strain rates of 7.5×10^4 sec^{-1}.