Hardness measurements across eleven decades of strain rate using a high throughput indentation method

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Abstract

This study presents a novel microindentation method that enables the measurement of hardness across eleven orders of magnitude in strain rate, from quasi-static to phonon drag-dominated rates, on a single material surface under uniform testing conditions. The approach combines standard and impact indentation with laser-induced particle impact testing (LIPIT) to evaluate hardness over a wide strain rate range. This method has been successfully applied to multiple materials, providing clearer insights into high-rate deformation mechanisms. Our results demonstrate a gradual increase in hardness with strain rate from quasi-static up to ultra-high rates, where a sharp upturn is observed.

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