DEVELOPMENT OF A CUSTOM HIGH STRAIN RATE NANOINDENTER FOR SMALL SCALE MECHANICAL CHARACTERIZATION OVER A WIDE RANGE OF STRAIN RATES

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Understanding the changes in mechanical behavior at high deformation speeds is crucial to increase the damage tolerance of components that are exposed to impacts during their lifetime, e.g. safety-relevant components in cars and airplanes. With the exception of nanoindentation impact tests [1], where the strain rate however varies with time, there is a deficit in experimental techniques for probing the mechanical behavior of coatings and small volumes at high strain rates. This especially prevents understanding the influence of the microstructure on elementary high-strain-rate deformation mechanisms. In this poster, we introduce a custom nanoindenter with enhanced electronic components, which is used to overcome the strain rate limitation of conventional constant strain rate nanoindentation (ca. 0.1 s^{-1}). An intrinsically displacement-controlled piezo-actuator is operated in combination with a piezo-based load cell and a 1 MHz data acquisition system. In combination with novel testing methods by Merle, Higgins and Pharr [2] measurements with constant indentation strain rates up to ca. 10^4 s^{-1} are allowed. This poster will focus on challenges in terms of time constant corrections and avoidance of resonance effects and show first applications to superplastic alloys investigated over several orders of magnitude of indentation strain rate.

[1] Sudharshan Phani, P., & Oliver, W. C. (2017). Ultra high strain rate nanoindentation testing. Materials, 10(6), 663.

[2] Merle, B., Higgins, W., & Pharr, G. (2020). Extending the range of constant strain rate nanoindentation testing. Journal of Materials Research, 35(4), 343-352.