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PUSHING THE ENVELOPE FOR HIGH TEMPERATURE NANOINDENTATION MEASUREMENTS

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One of the primary motivations for development of instrumented indentation was to measure the mechanical properties of thin films and individual phases/grains. Characterization of thin film mechanical properties as a function of temperature is of immense industrial and scientific interest. The major bottlenecks in elevated temperature measurements have been thermal drift, signal stability (noise) and oxidation of the surfaces. Thermal drift is a measurement artifact that arises due to thermal expansion/contraction of indenter tip and loading column. This gets superimposed on the mechanical behavior data precluding accurate extraction of mechanical properties of the sample at elevated temperatures. Vacuum is essential to prevent sample/tip oxidation and to push the envelope for high temperature testing.

This poster will present the high temperature vacuum nanoindenter designed at Anton Paar that can perform reliable load-displacement measurements over a wide temperature ranges (up to 700 °C). This system is based on the Ultra Nanoindentation Tester (UNHT) that utilizes an active surface referencing technique comprising of two independent axes, one for surface referencing and another for indentation. The differential depth measurement technology results in negligible compliance of the system due to symmetric architecture and very low thermal drift rates at high temperatures as the thermal drift is actively compensated by the surface referencing technology. The sample, indenter and reference tip are heated separately and the surface temperatures matched to obtain drift rates as low as 10 nm/min at 700 °C on copper Test results on standard calibration materials like fused silica and oxygen free high conductive copper, used for validating the system, will be presented. The developed experimental protocol for minimizing thermal drift and the challenges associated with high temperature testing will be discussed.