High-Temperature Scanning Indentation: A new method to investigate in situ metallurgical evolution along temperature ramps

- Gabrielle Tiphéne,
- Paul Baral,
- Solène Comby-Dassonneville,
- Gaylord Guillonneau,
- Guillaume Kermouche,
- Jean-Michel Bergheau,
- Warren Oliver &
- Jean-Luc Loubet

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I. Abstract

A new technique, *High-Temperature Scanning Indentation (HTSI)*, is proposed to investigate metallurgical evolution occurring during anisothermal heat treatments. This technique is based on the use of high-speed nanohardness measurements carried out during linear thermal ramping of the system with appropriate settings. A specific high-speed loading procedure, based on a quarter sinus loading function, a creep segment and a *three-step unloading method*, permits the measurement of elastic, plastic and creep properties. The indentation cycle lasts one second to minimize thermal drift issues. This approach enables quasi-continuous measurements of elastic modulus and hardness as a function of temperature in much shorter times than previous techniques.
The *HTSI* technique is validated on fused silica and pure aluminum. The application to cold-rolled aluminum undergoing thermal cycling highlights the potential of the *HTSI* technique to investigate in situ thermally activated mechanisms linked with microstructural changes such as viscoplasticity, static recovery and recrystallization mechanisms in metals. Results on aluminum were confirmed using Electron Back-Scattering Diffraction measurements.

II. Graphic abstract