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EXPERIMENTAL INVESTIGATION OF THERMOMECHANICAL PROPERTIES OF MULTIFUNCTIONAL MATERIALS AT IPPT PAN

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Currently, there is an increasing need for development of multifunctional materials with high properties and/or smart behavior to meet ever growing requirements of advanced industry and demanding global market. Examples of new advanced materials are shape memory alloys SMAs (TiNi) and shape memory polymers SMP (polyurethanes) which have the ability to return from a deformed state (temporary shape) to their original (permanent) shape induced by an external trigger, such as temperature change. Another multifunctional material is a Ti-based alloy Gum Metal characterized by a low elastic modulus (30-70 GPa) and high strength (over 1000 MPa), which was developed by Toyota Central Research and Development Labs at the beginning of the 21st century.

Mechanical performance of such materials is of key importance and it is also critical to study interaction between the mechanical and thermal fields, so-called thermomechanical coupling, which plays an important role in nature causing heating or cooling of objects when loaded and strained. A set-up for determination of thermomechanical coupling consists of a testing machine, which applies a predefined loading program to a tested material and an infrared camera, which collects an infrared radiation emitted from the specimen surface during the loading process for further calculations of temperature changes. Selected results of stress σ vs. strain ε and temperature change ΔT vs. strain ε for SMP under tension at $10^{-2}s^{-1}$ as well as σ, ε and ΔT vs. time for Gum Metal under tension at $10^{-3}s^{-1}$ are presented in Figure 1 a and 1 b, respectively. Next to the curves, distributions of temperature (thermograms) on the specimens (SMP and Gum Metal) surfaces captured by the infrared camera just before rupture showing a developed strain localization of the tested materials are shown. Results of experimental investigation of thermomechanical coupling provide insight into mechanisms of deformation of the studied materials. Maximal drop in the thermal response corresponds to yield limit of solids, which is especially difficult to be determined in materials with nonlinear deformation such as SMP and Gum Metal.

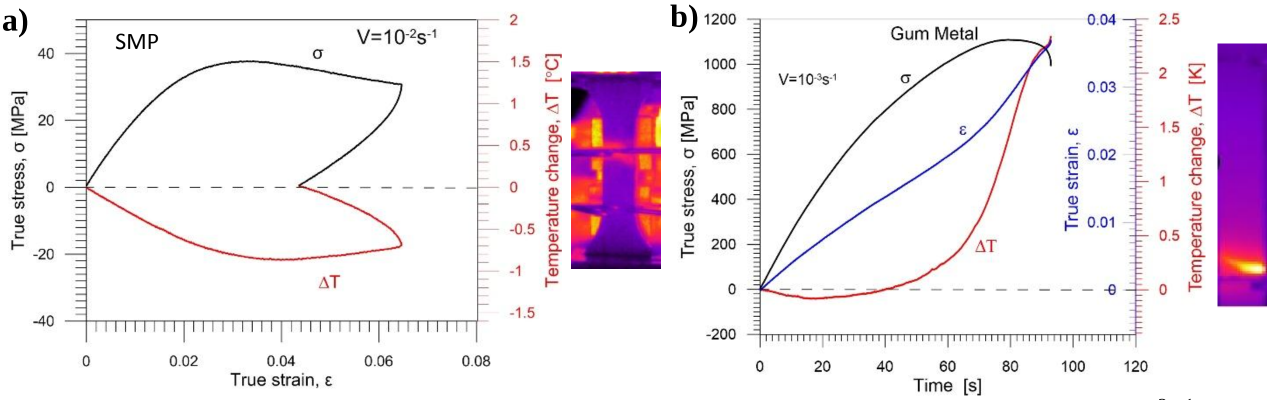

Fig. 1 a) Stress σ vs. strain ε and temperature change ΔT vs. ε for SMP under tension at $10^{-2}s^{-1}$ and b) stress σ, strain ε and temperature change ΔT vs. time for Gum Metal under tension at $10^{-3}s^{-1}$. Next to the diagrams thermograms at rupture are presented.

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