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Energy Storage and Dissipation in Shape Memory Polyurethane

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During deformation some part of external mechanical energy provided to the sample is dissipated, while the other part is remained in the material after unloading as stored energy [1-3]. In this work, the energy estimation was performed for polyurethane shape memory polymer PU-SMP with glass transition temperature $T_g \approx 25^\circ\text{C}$, manufactured by SMP Technologies Inc., Japan. For this purpose the investigated samples were subjected to tension loading on MTS 858 testing machine in room conditions with two strain rates of $2 \cdot 10^0 \text{s}^{-1}$ and $2 \cdot 10^{-1} \text{s}^{-1}$. The investigation was conducted for two strain ranges of 0.6 and 1.18, where the deformation was assumed as macroscopically homogeneous. The fast and sensitive infrared camera ThermoCam Phoenix was used in order to determine the temperature distributions on the sample surface and to obtain the sample temperature changes during tension. The estimated energies for the PU-SMP are plotted in Fig. 1.

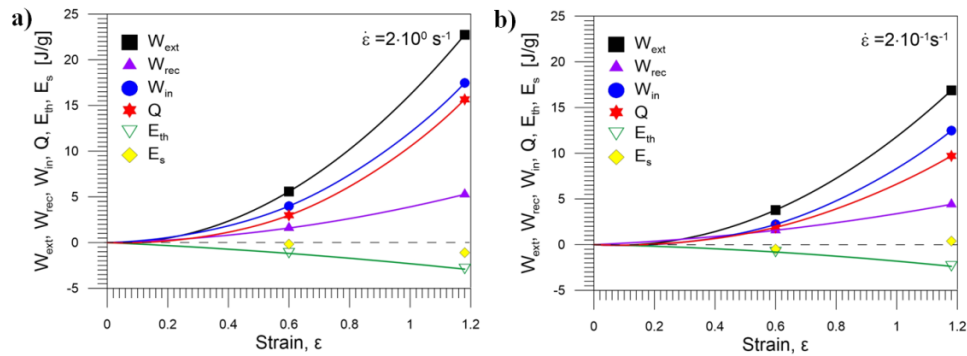


Fig. 1: Comparison of W_{ext} , W_{rec} , W_{in} , Q , E_{th} , E_s vs. strain for strain rates: a) $2 \cdot 10^0 \text{s}^{-1}$; b) $2 \cdot 10^{-1} \text{s}^{-1}$

It was found that the external mechanical energy provided to the sample during the deformation process W_{ext} , the inelastic energy W_{in} and the dissipated energy Q depend on the strain rate applied. The higher strain rate, the higher energy values were obtained. However, the values of recoverable energy W_{rec} and the energy of thermoelastic effect E_{th} almost did not depend on the strain rate. The estimated values of the stored energy E_s were close to zero. Therefore, it can be concluded that the energy was not stored in this polymer during the deformation process, but it was only dissipated, i.e. totally converted into heat. It should be also noted that the crystalline phase was not found in the PU-SMP.

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