Investigation of functional properties of polyurethane shape memory polymer; estimation of energy storage and dissipation

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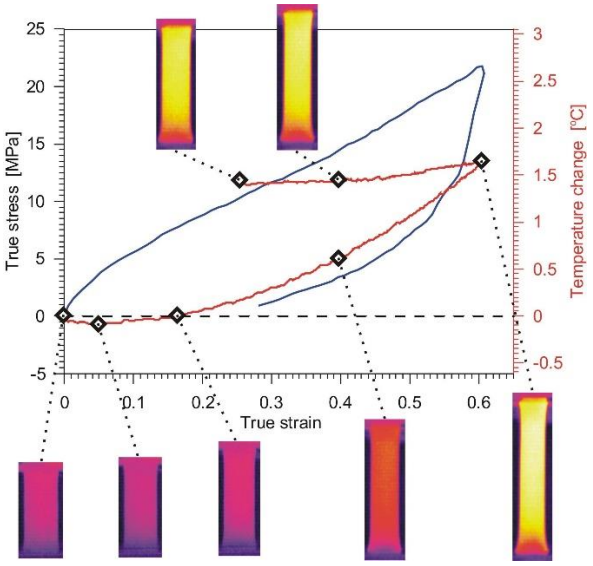
Shape Memory Polymer (SMP) belong to group of functional materials, characterized by shape memory property. It is a copolymer composed of hard and soft segments randomly distributed in volume which form a two-phase microstructure. The elastic modulus and the yield stress are high at temperatures below the glass transition temperature *Tg* and low above *Tg*. If the SMP is heated to the temperature above T_g, it can be deformed easily. After cooling below its T_g, followed by unloading to remove the stress, the modified shape is maintained. Heating again above T_g enables the SMP to return to the original shape. If SMP is deformed at temperatures above *Tg* and cooled down below *Tg* by holding the deformed shape constant, the shape is fixed and SMP can carry a large load. This property is called the shape fixity. If the shape-fixed SMP element is heated above *Tg* under no load, the original shape is recovered. This property is called the shape recovery. The shape memory property appears based on the glass transition in which the characteristics of molecular motion vary depending on the variation of temperature. Among the SMPs, the polyurethane PU-SMP with sheet, film, foam are practically used and strain of several hundred percent is recoverable [1].



The program proposed for the PhD project concerns an investigation of mechanical, thermomechanical and application properties of PU-SMP. Energy balance under loading and deformation will be conducted using the stress and temperature versus strain characteristics and experimentally obtained the SMP material parameters. The estimation of energy storage which was initiated in frames of [2] will be developed on other kind of SMP. The research will be conducted in collaboration with a Japanese center which provided us with thermoplastic Shape Memory Polyurethane samples.

1. Pieczyska E.A., Maj M., Kowalczyk-Gajewska K., Staszczak M., Gradys A., Majewski M., Cristea M., Tobushi H., Hayashi S., *Thermomechanical properties of polyurethane shape memory polymer–experiment and modelling*, SMART MATERIALS AND STRUCTURES, ISSN: 0964-1726, DOI: 10.1088/0964-1726/24/4/045043, Vol.24, pp.045043-1-16, 2015.

2. Maria Staszczak, Experimental analysis of thermomechanical and functional properties of selected shape memory polyurethanes, PhD thesis, IPPT PAN, 2019.