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BOOK OF ABSTRACTS

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Effect of Shape Recovery and Cyclic Loading on the Evolution of Micro-Cracks in Shape Memory Polymers

M. Nabavian Kalat, M. Staszczak, Y. Ziai, L. Urbański and E. Pieczyska

Institute of Fundamental Technological Research PAN, Warsaw, Poland
E-mail: mnabavian@ippt.pan.pl

Shape memory polymers (SMPs) have attracted a great attention as smart materials due to their high shape recovery characteristics. The mechanically deformed SMP recovers its original shape by being exposed to an external stimulus, e.g. heat [1]. In this study, the polyurethane shape memory polymer (PU-SMP) with $T_g = 45$°C, manufactured by the *SMP Technologies Inc.*, Tokyo, Japan, was subjected to one and five loading-unloading tensile cycles at strain rate of $10^{-2}s^{-1}$ up to maximum strain of 60%. The investigation was conducted on Instron 5969 testing machine at room temperature. The effect of (I) thermal shape recovery of the PU-SMP at the temperature $T_g + 20 = 65$°C and (II) number of loading-unloading cycles on the formation and healing of micro-cracks were investigated through microscopic observation by scanning electron microscope (SEM).

Detection of initiation and propagation of defects in materials and finding ways to avoid or heal them allows us to predict the behavior of the material during the service time and overcome the potential dangers of failure [2]. The results of our study proved that the mechanical deformation and shape recovery of the PU-SMP are related to the formation and healing of the micro-cracks, respectively. As demonstrated in Fig. 1, the cracks which were formed during the one loading-unloading cycle (Fig. 1a) are healed during the thermal shape recovery (Fig. 1b). Moreover, the micro-cracks which were formed during the one-cycle are also healed during five loading-unloading cycles (Fig. 1c).

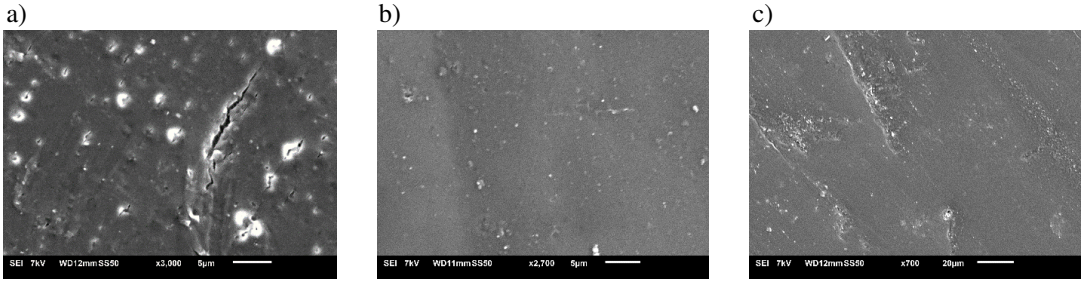

Figure 1: SEM images of PU-SMP specimen after a) one-cycle loading-unloading b) thermal shape recovery c) five-cycle loading-unloading.

Thermal shape recovery property of the PU-SMP enables the micro-cracks to be healed at the temperatures above T_g. Besides, there might be an optimum number of loading-unloading cycles in which micro-cracks formed in the PU-SMP specimen are healed.

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References

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