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Influence of grain size on super elasticity and actuation properties of Cu-Al-Mn shape memory alloys

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Grain size is one of the main microstructural parameters which dictate the shape memory properties of Cu-based shape memory alloys (SMAs). In this study, grain size control of $Cu_{73}Al_{16}Mn_{11}$ (%) shape memory alloy was achieved via cold rolling–short time post annealing technique. While homogenized material has an average grain size of 900 μm, 260 μm average grain size was obtained after 70% rolling at room temperature and subsequent 950°C 80 seconds heat treatment. Super elasticity and actuation properties of homogenized and thermo-mechanically treated material were compared by utilizing incremental cyclic tensile and isobaric heating-cooling experiments respectively. It was found that decreasing the grain size had no effect on the superelastic properties of the material, however, residual strains obtained from isobaric heating-cooling experiments decreased prominently. These two contradictory results can be explained by two mechanisms. Since stress level in super elasticity tests are higher (about 300 MPa when transformation starts) than that of in the case isobaric heating-cooling tests (maximum 140 MPa tension stress was applied), stress concentrations at the grain boundaries lead to intergranular fracture owing to high elastic anisotropy of the Cu-based SMAs. On the other hand, strengthening effect of grain size reduction is the main mechanism to increase the dimensional stability by impeding the motion of dislocations that occurs due to the martensitic transformation in isobaric heating-cooling experiments.

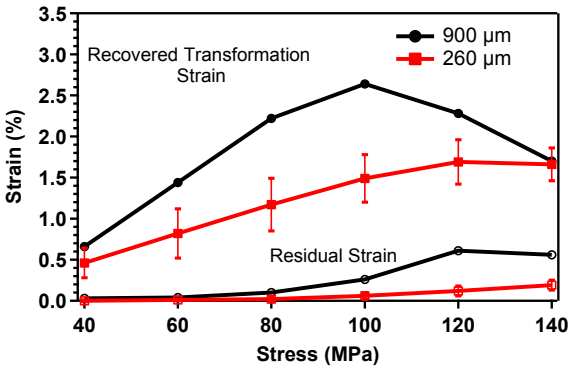

Figure 1: Recovered transformation strain and residual strain as a function of applied stress for materials that have different grain size

Biography

Nazim Babacanis is pursuing his PhD studies in the Department of Mechanical Engineering under the supervision of Dr. Benat Kockar and Dr. Selim Turkbas. The topic of his PhD thesis is "Enhancing mechanical properties of Cu-Al-Mn shape memory alloys". He was a Visiting Scholar at Texas A&M University under the supervision of Dr. Ibrahim Karaman. His studies focused on the actuation properties and thermo-mechanical stability behaviors of Cu-Al-Mn shape memory alloys within the scope of the thesis and found important results that clarify the relationship between microstructure and macro-behavior of these alloys.

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