ICAM 2009

Size effects on superelasticity in shape memory alloy submicron and micron-scale structures

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The superelasticity of shape memory alloys involves a large recoverable strain, e.g., up to about 8%, as a result of stress-induced martensitic transformation. However, the unloading and loading portions of the stress-strain curve do not overlap, but rather exhibit a hysteresis that reflects the dissipation of mechanical energy. In this talk, we will present our recent work on superelasticity in confined volumes and the associated size effects. We measure superelasticity in a Cu-Al-Ni alloy via micro-tension testing of wires with diameters ranging from ~500 down to ~20 micrometers, and at smaller, submicron scales, using focused ion beam micromachining and micro-compression testing. We establish that the martensitic transformation during loading, as well as the reverse transformation during unloading, both exhibit sample size dependence in this alloy. A major result of these size effects is that this alloy in small volumes exhibits much larger transformation hysteresis and hence higher mechanical damping capacity than macro-scale specimens.