Osman Adiguzel

Firat University, Department of Physics, Elazig, Turkey

Thermoelastic and Superelastic Characterization of Shape Memory Alloys

Some materials take place in class of smart materials with adaptive properties and stimulus response to the external changes. Shape memory alloys take place in this group, due to the shape reversibility and capacity of responding to changes in the environment. Shape memory alloys have a peculiar property to return to a previously defined shape or dimension when they are subjected to variation of temperature. These alloys can be deformed plastically in low temperature condition recover original shape on heating. Shape memory effect (SME) is performed by heating and cooling in a temperature interval, after first cooling and stressing processes. therefore, this behavior is called thermoelasticity. Superelasticity is performed a constant temperature by stressing and releasing at a constant temperature in the parent austenite phase region. These phenomenon are result of crystallographic transformations in the materials, called martensitic transformations. Shape memory effect is governed by successive thermal and stress induced martensitic transformations.

Thermal induced martensitic transformation occurs on cooling along with lattice twinning, with which ordered parent phase structures turn into twinned martensite structures; these twinned structures turn into detwinned martensite structures by means of strain induced martensitic transformation with deformation in martensitic state. These alloys exhibit another property called superelasticity (SE), which is performed in only mechanical manner. These alloys can be deformed in parent phase region just over austenite finish temperature, and recover the original shape on releasing the stress in superelastic manner.

Thermoelasticity is a result of successive thermal and stress martensitic transformations, whereas superelasticity is the result of stress-induced martensitic transformation, which occurs by only mechanical stress at a constant temperature. With this stress, parent austenite phase structures turn into the fully detwinned martensite. Superelasticity exhibits normal elastic material behaviour, but it is performed in non-linear way, unlike normal elastic materials. Loading and unloading paths are different, and hysteresis loop reveals energy dissipation. Thermal induced martensitic transformations occur with cooperative movement of atoms by means of lattice invariant shears on a {110} - type plane of austenite matrix which is basal plane of martensite, and ordered parent phase structures turn into twinned martensite structures.