Shape Reversibility and Basic Lattic Reactions in Shape Memory alloys

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Shape memory alloys take place in a class of advanced smart materials by exhibiting a peculiar property called shape memory effect. This property is characterized by the reversibility of two certain shapes of material at different conditions. With these properties, these alloys are used in many fields, such as bioengineering, metallurgy, building industry, and many engineering fields. These alloys exhibit dual characteristics, thermoelasticity and superelasticity from viewpoint of memory behavior. Thermoelasticity is initiated by cooling and stressing, and performed thermally on heating and cooling, by recovering the original and deformed shapes, respectively. Therefore this behavior is called thermoelasticity. Shape memory effect is based on dual crystallographic phase transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling along with lattice twinning, and ordered parent phase structures turn into twinned martensite structures. Twinned martensite structures turn into the detwinned martensite structures by means of stress induced martensitic transformation by stressing material in the martensitic condition. These alloys exhibit another property, superelasticity which is performed in only mechanical manner by stressing and releasing in the parent austenite phase region. Shape Memory Effect is performed thermally in a temperature interval depending on cooling and heating, whereas superelasticity is performed by stressing the material in the strain limit in the parent phase region, and shape recovery is performed simultaneously upon releasing the applied stress. Shape memory effect is result of successive thermally and stress induced martensitic transformations, whereas superelasticity is the result of stress-induced martensitic transformation and performed in non-linear way, unlike normal elastic. Loading and unloading paths are different, and cycling loop reveals energy dissipation. Thermal induced martensitic transformations occur on cooling with cooperative movement of atoms in <110 > -type directions by means of lattice invariant shears on a {110} - type plane of austenite matrix which is basal plane of martensite.
Copper based alloys exhibit this property in metastable beta-phase region. Lattice invariant shear and lattic twinning is not uniform in these alloys and cause to the formation of unusual complex layered structures. In the present contribution, x-ray diffraction and transmission electron microscopy (TEM) studies were carried out on two copper based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections inherited from parent phase due to the displacive character of martensitic transformation. Specimens of these alloys were aged at room temperature for along term, and x-ray diffractograms taken during ageing show that diffraction angles and peak intensities changed. This result refers to a new transition and rearrangement of atoms in diffusive manner.

Keywords:
Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, twinning, detwinning.

Biography

Dr Adiguzel graduated from Department of Physics, Ankara University, Turkey in 1974 and received PhD- degree from Dicle University, Diyarbakir-Turkey. He has studied at Surrey University, Guildford, UK, as a post doctoral research scientist in 1986-1987, and studied on shape memory alloys. He worked as research assistant, 1975-80, at Dicle University and shifted to Firat University, Elazig, Turkey in 1980. He became professor in 1996, and he has already been working as professor. He published over 60 papers in international and national journals; He joined over 100 conferences and symposia in international and national level as participant, invited speaker or keynote speaker with contributions of oral or poster. He served the program chair or conference chair/co-chair in some of these activities. In particular, he joined in last seven years (2014 - 2020) over 80 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. He supervised 5 PhD- theses and 3 M.Sc- theses. Dr. Adiguzel served his directorate of Graduate School of Natural and Applied Sciences, Firat University, in 1999-2004. He received a certificate awarded to him and his experimental group in recognition of significant contribution of 2 patterns to the Powder Diffraction File – Release 2000. The ICDD (International Centre for Diffraction Data) also appreciates cooperation of his group and interest in Powder Diffraction File.

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