**The Role of Thermal and Mechanical Reactions in Memory Behavior of Shape Memory Alloys**

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**Abstract:**

Some materials take place in class of advanced smart materials with adaptive properties and stimulus response to the external changes. Shape memory alloys take place in this group, by exhibiting a peculiar property called shape memory effect with reversibility characteristics. High temperature phases of these alloys are hard phase, low temperature phases are soft phase, and they exhibit two behaviors, thermoelasticity and superelasticity, from viewpoint of reversibility. Shape memory effect is initiated by thermomechanical treatments on cooling and deformation and performed thermally on heating and cooling, with which shape of material cycles between original and deformed shapes in reversible way. Therefore, this behavior can be called Thermoelasticity. This is plastic deformation, with which strain energy is stored in the materials and released on heating by recovering the original shape. Superelasticity is performed mechanically with stressing and releasing the material in elasticity limit at a constant temperature in parent phase region, and shape recovery occurs instantly upon releasing. Superelasticity exhibiting elastic material behaviour, but stress-strain profile exhibit nonlinear behaviour and hysteresis loop refers to energy dissipation. These behaviours are governed by the thermal and mechanical reactions, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling with the cooperative movement of atoms in <110>-type directions on {110}-type planes of austenite matrix along with lattice twinning, by means of lattice invariant shears, and ordered parent phase structures turn into twinned martensite structures. Twinned martensite structures turn into detwinned martensite structures by means of stress induced transformation with deformation.

Copper based alloys exhibit this property in metastable β-phase region, which has bcc-based structures. Lattice invariant shears and lattice twinning are not uniform in these alloys, and cause to formation of long period layered structures with martensitic transformation. The long-period layered structures can be described by different unit cells as 3R, 9R or 18R depending on the stacking sequences on the close-packed planes of the parent phase.

In the present contribution, x-ray diffraction and transmission electron microscopy studies were carried out on copper based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections inherited from parent phase. X-ray diffractograms taken in a long-time interval show that diffraction angles and intensities of diffraction peaks change with the aging time at room temperature, and this result refers to a new transformation in diffusive manner.

**Keywords:** Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, thermoelasticity, lattice twinning and 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 were focused on shape memory effect in shape memory alloys. His academic life started following graduation by attending an assistant to Dicle University in January 1975. He became professor in 1996 at Firat University in Turkey, and retired on November 28, 2019, due to the age limit of 67, following academic life of 45 years. He supervised 5 PhD- theses and 3 M. Sc- theses and published over 80 papers in international and national journals; He joined over 120 conferences and symposia in international level with contribution. He served the program chair or conference chair/co-chair in some of these activities. Also, he joined in last six years (2014 - 2019) over 60 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. Additionally, he joined over 70 online conferences in the same way in pandemic period of 2020-2021.

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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