**Thermomechanical Processes and Phase Transformations in Shape Memory Alloys**

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Metals and many alloy systems have different phases with chemical composition at the phase diagrams in composition-temperature or composition-pressure space. A series of alloy systems, called shape memory alloys, exhibit a peculiar property called shape memory effect in β-phase region. This phenomenon is initiated with thermomechanical processes on cooling and deformation, and performed thermally on heating and cooling, with which shape of the materials cycle between original and deformed shapes in reversible ways. Therefore, this behavior can be called thermoelasticity. This is plastic deformation, due to the soft character of the material in low temperature condition, with which strain energy is stored in the materials and release upon heating, by recovering original shape. Shape memory effect is governed by crystallographic transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling, with cooperative movement of atoms in <110 > -type directions on the {110} - type planes of austenite matrix, along with lattice twinning reaction, and ordered parent phase structures turn into twinned martensite structures. The twinned structures turn into detwinned martensite structures by means of stress induced transformation with stressing the material in the martensitic condition. These reactions are driven by lattice invariant shear.

These alloys exhibit another property called superelasticity, which is performed with mechanically stressing and releasing the material in elasticity limit at a constant temperature in parent phase region and shape recovery occurs instantly upon releasing, by exhibiting elastic material behavior. Stress-strain profile exhibits nonlinear behavior at stress-strain diagram, stressing and releasing paths are different and hysteresis loops refers to energy dissipation. This phenomenon is also result of stress induced martensitic transformation and ordered parent phase structures turn into detwinned martensite structure with stressing. Copper based alloys exhibit this property in metastable β-phase region. Lattice twinning and lattice invariant shear are not uniform in these memory alloys and gives rise to the formation of layered structures, like 3R, 9R or 18R depending on the stacking sequences on the {110} - type close-packed planes of the parent phase. Unit cell and periodicity is completed through 18 layers in 18R structures in ternary copper-based alloys. In the present contribution, x-ray diffraction and electron diffraction studies were carried out on copper based CuZnAl and CuAlMn alloys. X-ray diffraction profile and electron diffraction patterns exhibit super lattice scattering. Critical transformation temperatures of these alloys are over the room temperature, at which alloy samples are completed in the martensitic state. These alloy samples were aged at room temperature. X-ray diffractograms taken in a long-time interval show that scattering angles, peak intensities, and characteristics change with ageing at room temperature. This result refers to the rearrangement of atoms in diffusive manner.

**Keywords:** Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, lattice invariant shear, 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 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 120 online conferences in the same way in pandemic period of 2020-2022.

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.

