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### **Memory Characteristics and Crystallographic Transformations governing reversibility in shape memory alloys**

#### **Abstract:**

Shape memory alloys take place in a class of advanced smart materials by exhibiting dual memory characteristics, shape memory effect and superelasticity, with the recoverability of two shapes at different conditions. Shape Memory Effect is initiated with thermomechanical treatments on cooling and deformation and performed thermally on heating and cooling, with which shape of the material cycles between original and deformed shapes in reversible way. Therefore, this behavior can be called thermal memory or thermoelasticity. This phenomenon is governed by the crystallographic transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformations occur on cooling with cooperative movement of atoms in  $\langle 110 \rangle$ -type directions on  $\{110\}$ -type close packed planes of austenite matrix, along with lattice twinning and ordered parent phase structures turn into the twinned martensite structures. The twinned structures turn into detwinned martensite structures by means of stress induced martensitic transformations with deformation in the low temperature condition. Superelasticity is performed by mechanically stressing and releasing in elasticity limit at a constant temperature in the parent phase region, and material recovers the original shape upon releasing, by exhibiting elastic material behavior. Superelasticity is also result of stress induced martensitic transformation, and the ordered parent phase structures turn into the detwinned martensite structures with stressing. However, lattice twinning and detwinning reactions play important role in martensitic transformations, and they are driven by internal and external forces by means of inhomogeneous lattice invariant shears. These alloys are functional materials with these properties and used in many fields from biomedical application to the building industry. Copper based alloys exhibit this property in metastable  $\beta$ -phase region. Lattice twinning and lattice invariant shear are not uniform in these alloys and cause the formation of complex layered structures. These 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 ordered lattice. In the present contribution, x-ray and elec-

tron diffraction studies were carried out on copper based CuAlMn and CuZnAl alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections. Critical transformation temperatures of these alloys are over room temperature. The specimens were aged at room temperature and taken a series of x-ray diagram during aging. X-ray diffractograms taken in a long-time interval show that diffraction angles and intensities of diffraction peaks change with the aging duration at room temperature. This result refers to the rearrangement of atoms in diffusive manner.

## Biography

**Adiguzel** graduated from Department of Physics, Ankara University, Turkey in 1974 and received PhD- degree from Dicle University, Diyarbakir-Turkey. He 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 been retired on November 28, 2019, due to the age limit of 67, following academic life of 45 years. He published over 80 papers in international and national journals; He joined over 120 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 six years (2014 – 2019) over 60 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. Also, he joined over 230 online conferences in the same way in pandemic period of 2020–2024. 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.