ISBN:
978-1-917892-15-5



**Osman Adiguzel**

*Firat University, Department of Physics, Elazig, Turkey*

## Chemical Factors and Crystallographic Transformations Governing Reversibility in Shape Memory Alloys

Metals and many alloy systems have different phases at different conditions and these phases are described in phase diagrams. Shape memory alloys exhibit a peculiar property called shape memory effect in β-phase region with chemical composition. These alloys are very sensitive to external conditions, and crystal structures turn into other structures by lowering temperature and stressing material, by means of crystallographic transformation, thermal and stress induced martensitic transformations. Lattice vibrations (phonons), atomic bonds and interatomic interactions play an important role in the processing of transformation. Shape memory effect is initiated 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 Thermoelasticity. This phenomenon is characterized by the recoverability of two certain shapes of material at different temperatures.

Thermal induced martensitic transformation occurs on cooling with cooperative movements of atoms in <110 > -type directions on the {110} - type planes of austenite matrix, along with lattice twinning and ordered parent phase structures turn into the twinned martensite structures. The twinned structures turn into the detwinned structures by means of stress induced martensitic transformation with deformation in the martensitic condition. These alloys exhibit another property called superelasticity, which is performed by stressing and releasing material in elasticity limit at a constant temperature in parent phase region, and shape recovery is performed simultaneously upon releasing. Superelasticity is also result of stress induced martensitic transformation and ordered parent phase structures turn into detwinned martensite structure with stressing. These alloys exhibit another property called superelasticity, which is performed by stressing and releasing material in elasticity limit at a constant temperature in parent phase region, and shape recovery is performed simultaneously upon releasing.

Superelasticity is also result of stress induced martensitic transformation and ordered parent phase structures turn into detwinned martensite structure with stressing. 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. Copper- based alloys exhibit this property in metastable β-phase region. Lattice twinning is not uniform in these alloys and gives rise to the formation of complex layered structures. The 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 ordered lattice.

In the present contribution, x-ray and electron diffraction studies were carried out on two copper- based CuAlMn and CuZnAl alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections. 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.

**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 were focused on shape memory effect in shape memory alloys. He worked as research assistant, in 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 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 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. 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