**Crystallographic Basis and Mechanism of Shape Reversibility in Shape Memory Alloys**

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**Abstract**

A series of alloy systems 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, due to the shape reversibility and capacity of responding to changes in the environment. These alloys exhibit a peculiar property called shape memory effect, which is characterized by the recoverability of two certain shapes at different temperatures. This phenomenon is initiated by cooling and deformation processes and performed thermally on heating and cooling. Therefore- this behavior can be called thermoelasticity. These alloys have dual characteristics called thermoelasticity and superelasticity, from viewpoint of memory behavior. Two successive structural transformations, thermal and stress induced martensitic transformations govern shape memory phenomena in crystallographic basis. Thermal induced transformation occurs along with crystal twinning on cooling and ordered parent phase structures turn into twinned martensite structures, and twinned structures turn into the detwinned structures by stressing material in low temperature condition by means of stress induced transformation. Superelasticity is performed mechanically by stressing and releasing material at a constant temperature in parent phase region, and shape recovery is performed simultaneously upon releasing the applied stress. Superelasticity is performed in non-linear way; stressing and releasing paths are different in the stress-strain diagram, and hysteresis loop refers to energy dissipation.

The elementary processes involved in such martensitic transformations are lattice invariant shear, lattice twinning and detwinning. It is well known that crystal twinning and detwinning reactions play a considerable role in shape memory effect and superelasticity. Thermal induced martensitic transformation is lattice-distorting phase transformation occur with the cooperative movement of atoms by means of shear-like mechanism in <110>-type directions on {110} -type planes of austenite matrix.

Copper based ternary alloys exhibit shape memory in β-phase field. Lattice invariant shear and twinning is not uniform in these alloys, and cause to the formation of long-period layered martensitic structures with lattice twinning on cooling.

In the present contribution, electron diffraction and x-ray diffraction studies performed on two copper based CuZnAl and CuAlMn alloys. Electron diffraction patterns and x-ray diffraction profiles exhibit super lattice reflection. Specimens of these alloys aged at room temperature, and a series of x-ray diffractions were taken duration aging. Reached results show that diffraction angles and peak intensities change with aging time. Especially, some of the successive peak pairs providing a special relation between Miller indices come close each other, and this result refers to the rearrangement of atoms in diffusive manner.

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

**Biography (upto 150 words)**

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 80 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 70 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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