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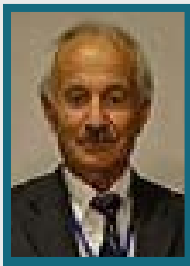

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Structural reactions and functional characterization of shape memory alloys

Metals and metallic alloys exist different crystal phases at the different temperatures and pressures with crystal structures depending on alloy compositions. Crystal structures of these alloys turn to other structures with variation of temperature and stressing by means of crystallographic transformations. A series of alloy system take place in a class of advanced smart materials with the stimulus response to external effect. Shape memory alloys take place in this class by exhibiting a peculiar property called shape memory effect. This phenomenon is characterized by the recoverability of two certain shapes of material in reversible way at different conditions. These alloys are used as shape memory devices in many fields from medicine, biomedical to the building industry. Shape memory effect is initiated on cooling and deformation and performed thermally in a temperature interval on heating and cooling, with which shape of materials cycles between original and deformed shapes in reversible way. Therefore, this behavior is called thermo elasticity.

This phenomenon is governed by structural transformations thermal, and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling with cooperative movements of atoms by means of lattice invariant shears in <110>-type directions on the {110}-type planes of austenite matrix and ordered parent phase structures turn into the twinned martensite structures, along with lattice twinning. Twinned structures turn into the detwinned martensite structures by means of stress induced martensitic transformation with stressing. Movements of atoms are confined to interatomic distances. Therefore, these transformations have diffusion less character.

These alloys exhibit another property, called super elasticity, which is performed with stressing and releasing in elasticity limit at a constant temperature in parent phase region, and shape recovery is performed instantly and simultaneously upon releasing the applied stress, by exhibiting elastic material behavior. Stress-strain profile is nonlinear in stress-strain diagram, also stressing and releasing paths are different, and hysteresis loops refers to energy dissipation, and these alloys can be used in building industry against seismic events with this property.

Copper based alloys exhibit this property in metastable ß-phase region which has bcc-based structures. Lattice invariant shear and twinning is not uniform in these alloys and gives rise to 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.

In the present contribution, X-ray diffraction and Transmission Electron Microscopy (TEM) studies were carried out on 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 peak intensities change with aging duration at room temperature. This result refers to the rearrangement of atoms in diffusive manner.

Keywords: Shape memory effect, Martensitic transformation, Thermo elasticity, Super elasticity, Twinning, Detwinning.

Biography

Adiguzel O 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. He 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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