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Shape memory phenomena and nanoscale aspects of reversibility in shape memory alloys

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Shape memory alloys take place in a class of smart materials by exhibiting a peculiar property called shape memory effect. This property is characterized by the recoverability of two certain shapes of material at different temperatures. These materials are often called smart materials with the functionality and capacity of responding to changes in the environment. These materials are used as shape memory devices in many interdisciplinary fields such as medicine, bioengineering, metallurgy, building industry and many engineering fields. Shape memory effect is initiated by cooling and deformation, and performed thermally by heating, and this behavior is called thermoelasticity.This phenomenon is based on lattice reactions, called martensitic transformation, and this transformation is characterized by changes in the crystal structure of the material. This is plastic deformation; strain energy is stored after releasing and released on heating by recovering the original shape of material. These alloys are mainly used as deformation absorbent materials in control of civil structures subjected to seismic events, due to the absorbance of strain energy during any disaster or earthquake. These alloys exhibit another property, called superelasticity performed by stressing and releasing the material in parent phase region. Loading and unloading paths are different in stress strain diagram, and cycling loop refers to the energy dissipation. Thermal induced martensitic transformation occurs on cooling along with lattice twinning with cooperative movements of atoms by means of lattice invariant shear, which occurs in two opposite directions, 110 type directions on the 110 type planes of austenite matrix. Ordered parent phase structures turn into twinned martensite structures with thermal induced transformation, and the twinned structures turn into the detwinned structures by means of stress induced martensitic transformation by stressing the material in the martensitic condition.

Copper based alloys exhibit this property in metastable β-phase region, which has bcc-based structures at high temperature parent phase field. Lattice invariant shear and twinning is not uniform in copper based ternary alloys and gives rise to the formation of complex layered structures, depending on the stacking sequences on the close-packed planes of the ordered parent phase lattice.

In the present contribution, x-ray diffraction and transmission electron microscopy (TEM) studies were carried out on two copper based CuAlMn and CuZnAl alloys. X-ray diffraction profiles and electron diffraction patterns reveal that both alloys exhibit super lattice reflections inherited from parent phase due to the displacive character of martensitic transformation. 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. Especially, some of the successive peak pairs providing a special relation between Miller indices come close each other. This result refers to the rearrangement of atoms in diffusive manner.

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, 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 70 online conferences in the same way in pandemic period of 2020-2021.

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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