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Dual thermoelastic and superelastc characterization of shape memory alloys

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Some materials take place in class of 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 have a peculiar property called shape memory effect. Shape memory effect is initiated by cooling and stressing treatments in material in bulk level and performed thermally on heating and cooling after first treatments. Therefore, this behavior is called thermoelasticity. These alloys exhibit another property called superelasticity, which is performed by stressing and releasing at a constant temperature in the parent austenite phase region. Shape memory effect is result of successive thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling along with lattice twinning, with which ordered parent phase structures turn into twinned martensite structures, and twinned structures turn into detwinned martensite structures by means of strain induced martensitic transformation with deformation in martensitic state. Thermal transformations occur with cooperative movement of atoms by means of lattice invariant shears in <110>-type directions on a {110} - type plane of austenite matrix.

Superelasticity is performed in only mechanical manner. These alloys can be deformed in parent phase region just over austenite finish temperature and recover the original shape on releasing the applied stress. Superelasticity is also result of stress induced martensitic transformation which occurs only by mechanical stress at a constant temperature. With this stress, parent austenite phase structures turn into the fully detwinned martensite. Superelasticity exhibits normal elastic material behaviour, but it is performed in non-linear way, unlike normal elastic materials. Loading and unloading paths are different, and hysteresis loop refers to the energy dissipation.

Copper based alloys exhibit this property in metastable phase region, which has bcc-based structures at high temperature parent phase field. Lattice invariant shear and twinning is not uniform in copper alloys and they give rise to the formation of unusual layered complex structures, like 3R, 9R or 18R structures depending on tha stacking sequences, with lattice twinning.

In the present contribution, x-ray diffraction and transmission electron microscopy studies were carried out on two copper based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections inherited from parent phase due to the displacive character of martensitic transformation. Specimens of these alloys aged at room temperature in martensitic condition, and a series of x-ray diffractions were taken duration aging at room temperature. Reached results show that diffraction angles and peak intensities change with aging time at room temperature, and this result leads 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 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 60 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 80 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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