2022
February 18-19
Webinar

3rd International Conference on
Physics

Physics of Thermal and Mechanical Memory in Shape Memory Alloys

Osman Adiguzel
Firat University, Turkey

Shape memory alloys take place in class of smart materials with adaptive properties and stimulus response to the external changes. These alloys exhibit a peculiar property called shape memory effect. This phenomenon is initiated by thermal and mechanical treatments on cooling and stressing the material and performed thermally on heating and cooling after these treatments. Therefore, this behavior is called thermal memory or thermoelasticity. Low temperature phases of shape memory alloys are soft phases and deformed easily. The material keeps the deformed shape after releasing external forces, the deformation energy is stored in the materials, and releases on heating by recovering the original shape. These alloys exhibit another property, called superelasticity, which is performed in only mechanical manner, by stressing and releasing. Therefore, this behavior can be called mechanical memory. The alloys are stressed in parent phase region just over austenite finish temperature and recover the original shape simultaneous and instantly on releasing the external forces. These phenomena are result of crystallographic or structural transformations in the materials, called martensitic transformations, by which crystalline structure of the material change. Shape memory effect is governed by thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs in <110> - type directions on {110} - type planes of austenite, by means of lattice invariant shear, on cooling along with lattice twinning and ordered parent phase structures turn into twinned martensite structures; these twinned structures turn into detwinned martensite structures by means of strain induced martensitic transformation with deformation in martensitic state. Superelasticity is also the result of stress-induced martensitic transformation, and parent austenite phase structures turn into the fully detwinned martensite with the stressing. Superelasticity exhibits ordinary elastic material behavior, but it is performed in non-linear way; loading and unloading paths are different at the stress-strain diagram, and hysteresis loop reveals energy dissipation. Copper based alloys exhibit this property in metastable β - phase region, which has bcc-based structures at high temperature parent phase field. Lattice invariant shears and twinning are not uniform in these alloys and give rise to the formation of unusual layered complex structures, like 3R, 9R or 18R structures depending on the stacking sequences, with lattice twinning. The unit cell and periodicity are completed through 18 layers in direction z, in case of 18R martensite, and unit cells are not periodic in short range in direction z. 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 were aged at room temperature for a long term, and x-ray diffractograms taken during ageing show that diffraction angles and peak intensities changed. This result refers to redistribution of atoms in diffusive manner

Keywords: Thermoelasticity, superelasticity, shape memory effect, martensitic transformation, lattice twinning, detwinning.

Biography

Adiguzel graduated from Department of Physics, Ankara University, Turkey in 1974 and received PhD- degree from Dicle University, Diyarbakir-Turkey. He 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 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 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.

Received: November 22 2021 | **Accepted:** November 23,2021 | **Published:** February 18, 2022