Osman Adiguzel, Int J Mater Sci Res. 2018
http://dx.doi.org/10.18689/2638-1559.a2.002

Microstructural Basis of Thermoelasticity and Pseudoelasticity in Shape Memory Alloys

Osman Adiguzel
Firat University, Turkey

Shape memory effect (SME) is a peculiar property exhibited a series alloy systems. Successive structural transformations govern memory behavior. These transformations are induced by decreasing temperature and stressing material in low temperature by means of thermal induced and stress induced martensitic transformations. Shape memory effect is performed only thermally after these processes in a temperature interval, and this behavior is called thermoelasticity. Thermal induced martensitic transformation occurs as martensite variants with lattice twinning by means of shear-like mechanism in crystallographic scale, in materials on cooling. Twinned martensite structures turn into detwinned martensite structure by means of stress induced transformation by deforming plastically in martensitic condition. Martensitic transformations occur by two or more lattice invariant shears on a {110}-type plane of austenite matrix which is basal plane or stacking plane for martensite.

Shape memory alloys exhibit another property called pseudoelasticity (PE), which 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 stress in pseudoelastic manner. Both SME and PE is associated martensitic transformation. SME is a result of thermally induced martensitic transformation and deformation of material in the product martensite region, whereas PE is the result of stress-induced martensitic transformation, which occurs by only mechanical stress at a constant temperature. With this stress, parent austenite phase structures turn into the fully detwinned martensite.

Copper based alloys exhibit this property in metastable β-phase region. Lattice invariant shears are not uniform in these alloys, and the ordered parent phase structures martensitically undergo the non-conventional long-period layered structures on cooling. The long-period layered structures can be described by different unit cells depending on the stacking sequences on the close-packed planes of the ordered lattice. The close-packed planes, basal planes, exhibit high symmetry and short range order as parent phase. The unit cell and periodicity is 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 and electron diffraction studies were carried out on two copper based CuZnAl and CuAlMn alloys. These alloy samples have been heat treated for homogenization in the β-phase fields. 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 time at room temperature, and this result leads to the rearrangement of atoms in diffusive manner.

Keywords: Shape memory effect, martensitic transformation, thermoelasticity, pseudoelasticity, lattice twinning and detwinning.

Biography:

Dr. Osman 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 moved to Firat University, Elazig, Turkey in 1980. He became professor in 1996, and he has already been working as professor. He published over 50 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 four years (2014 - 2017) over 30 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. He supervised 5 Ph.D 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.