Journal of Material Sciences & Engineering
ISSN 2169-0022
2020
Vol.9 No.5

Shape reversibility and diffusionless phase transformations in shape memory alloys

Osman Adiguzel

Firat University, Turkey

Abstract

Shape memory alloys take place in a class of functional 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 conditions, and shape reversibility between critical low and high temperatures, which are martensite finish and austenite finish temperatures. Shape memory effect is based on two diffusionless phase transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling along with lattice twinning with cooperative movements of atoms in atomic scale, with which ordered parent phase structures turn into twinned martensite structures. This transformation occurs as martensite variants with lattice invariant shears which occur in <110> -type directions on the {110}-type planes of austenite matrix, and twinned martensite structures turn into the detwinned martensite structures by means of stress induced martensitic transformation by stressing material in the martensitic condition. Martensitic transformations have diffusionless character and movements of atoms are confined to inter atomic distances.

Copper based alloys exhibit this property in metastable β-phase region, which has bcc-based structures. Lattice invariant shears are not uniform in these alloys, and the ordered parent phase structures martensitically undergo the non-conventional complex layered structures on cooling. The long-period layered structures can be described by different unit cells as 3R, 9R or 18R, depending on the stacking sequences on the close-packed planes of the ordered lattice. 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 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 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. This result reveals a new transformation in diffusive manner.

Biography:

Osman 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.

Speaker Publications:

1. O. Adigüzel, Martensite ordering and stabilization in copper based shape memory alloys, Materials Research Bulletin, Volume 30, Issue 6, 1995, Pages 755-760.
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21st World Congress on Materials Science and Engineering; Webinar - June 22-23, 2020.

Abstract Citation:

Osman Adiguzel, Shape reversibility and diffusionless phase transformations in shape memory alloys, Materials Congress-2020, 21st World Congress on Materials Science and Engineering; Webinar - June 22-23, 2020.

(https://materialsscience.insightconferences.com/abstract/2020/shape-reversibility-and-diffusionless-phase-transformations-in-shape-memory-alloys)