March 17, 2022
Webinar

International Conference on
NANO MATERIALS

Journal of Material Sciences & Engineering
ISSN: 2169-0022

Lattice Reactions Governing Phase Transformations in Shape Memory Alloys

Osman Adiguzel

Firat University, Turkey

Shape memory alloys take place in advanced smart materials by exhibiting a peculiar property called shape memory effect, with dual thermoelastic and superelastic characteristics. These alloys have shape reversibility at different conditions and shape of material cycled between original and deformed shapes at different condition. Shape memory effect is initiated by cooling and deformation the material and performed thermally on heating and cooling after first cooling and stressing treatments. Therefore, this behavior is called thermoelasticity. Superelasticity is another property and performed in only mechanical manner. These alloys can be stressed in the elasticity limit in parent phase region of the material and recover the original shape on releasing the external forces. These phenomena are result of crystallographic transformations in the materials, called martensitic transformations. Shape memory effect is governed by successive thermal, and stress induced martensitic transformations. Thermal induced martensitic transformation occurs 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 normal elastic material behavior, but it is performed in non-linear way; loading and unloading paths are different, and hysteresis loop reveals energy dissipation. Thermal induced martensitic transformations occur with cooperative movement of atoms by means of lattice invariant shears in <110> - type planes on {110} - type planes of austenite.

Copper based alloys exhibit this property in metastable B - phase region, which has bcc-based structures. 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 the stacking sequences, with lattice twinning. 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 exhibit super lattice reflections inherited from parent phase due to the displacive character of martensitic transformation.

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

Recent Publications

O Adiguzel, Phase Transitions and Microstructural Processes in Shape Memory Alloys, Materials Science Forum, 2013 762 483-486, Trans Tech Publications, Switzerland

O Adiguzel, Self-accommodating Nature of Martensite Formation in Shape Memory Alloys, Solid State Phenomena, 2015 213 114-118, Trans Tech Publications,

O Adiguzel, Nanoscale Aspects of Phase Transitions in Copper Based Shape Memory Alloys, Nanotechnology in the Security Systems, NATO Science for Peace and Security Series C: Environmental Security 2015. 131-134

O Adiguzel, Phase Transitions and Elementary Processes in Shape Memory Alloys, Advanced Materials Research, 2015 1101 124-128, Trans Tech Publications, Switzerland

O Adiguzel, Nano-Scale Mechanisms in the Formation of Displacive Transitions in Shape Memory Alloys, Physics, Chemistry and Applications of Nanostructures - Proceedings of the International Conference Nanomeeting 2013. Edited by Borisenko Victor E et al. Published by World Scientific Publishing Co. Pte. Ltd

Journal of Material Sciences & Engineering
ISSN: 2169-0022

O Adiguzel, Ageing dependence and martensite stabilization in copper-based shape memory alloys, IOP Conf. Series: Materials Science and Engineering 60 2014 012001, Proceedings of International Symposium on Advanced Materials (ISAM2013), 23-27, September 2013, Islamabad, Pakistan

O Adiguzel, Thermoelasticity, Superelasticity and Nanoscale Aspects of Structural Transformations in Shape Memory Alloys. In: Struble L., Tebaldi G. (eds) Materials for Sustainable Infrastructure 2018 GeoMEast 2017. Sustainable Civil Infrastructures. Springer

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 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.

oadiguzel@firat.edu.tr