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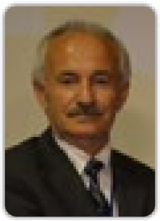

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Shape Reversibility and Functional Characterization of Shape Memory Alloys

A series of alloy system take place in a class of advanced functional materials with the stimulus-response to external effect. Shape memory alloys take place in this class by exhibiting a peculiar property called the shape memory effect. This phenomenon is characterized by the recoverability of two certain shapes of material in a reversible way under different conditions. These alloys are used as shape memory devices in many fields from medicine, metallurgy, building industry. The choice of material is very essential to developing main materials and structures These alloys have dual characteristics called thermoelasticity and superelasticity in a memory manner. The shape memory effect is initiated by cooling and deformation and performed thermally in a temperature interval on heating and cooling after the first cooling and stressing processes, and this behavior is called thermoelasticity. Superelasticity is performed by stressing and releasing material at a constant temperature in the parent phase region. For the Superelasticity, materials are stressed in the elasticity limit in the parent phase region and, shape recovery is performed instantly and simultaneously upon releasing the applied stress, by recovering the original shape. Superelasticity exhibits elastic material behavior but stressing and releasing paths are different at the stress-strain profile, and the hysteresis loop refers to the energy dissipation. These phenomena are governed by structural transformations, basically called martensitic transformations. The shape memory effect is governed by thermal, and stress-induced martensitic transformations and performed thermally, on heating and cooling. Thermal induced martensitic transformation occurs on cooling with cooperative movements of atoms by means of lattice invariant shears in two opposite directions, <110 > -type directions on the {110} - type planes of austenite matrix along with lattice twinning and ordered parent phase structures turn into the twinned martensite structures. The twinned structures turn into the detwinned structures by means of stress-induced martensitic transformation, by stressing material in the martensitic condition. Superelasticity is also the result of stress-induced martensitic transformation and ordered parent phase structures turn into the detwinned martensite structure with stressing. Copper-based alloys exhibit this property in the metastable β-phase region, which has bcc-based structures at a high-temperature parent phase field. Lattice invariant shear and twinning are not uniform in these alloys and give rise to the formation of complex layered structures, depending on the stacking sequences on the close-packed planes of the ordered parent phase lattice. The 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. In the present contribution, x-ray diffraction and transmission electron microscopy (TEM) studies were carried out on two copper-based CuAlMn and CuZnAl alloys. X-ray diffraction profiles and electron diffraction patterns exhibit superlattice reflections. X-ray diffractograms took in a long-time interval show that diffraction angles and intensities of diffraction peaks change with the aging duration at room temperature. This result refers to the rearrangement of atoms in a diffusive manner.

Recent Publications

1. Osman Adiguzel, et al (2021). Lattice Reactions Governing Thermoelasticity and Superelasticity in Shape Memory Alloys. Phys Sci & Biophys J 2021, 5(1): 000170
2. Osman Adiguzel (2020). Factors and Lattice Reactions Governing Phase Transformations in Beta Phase Alloys. In: Bonča, J., Kruchinin, S. (eds) Advanced Nanomaterials for Detection of CBRN, 101-109.
3. Osman Adiguzel (2020). Thermally and Stress Induced Phase Transformations and Reversibility in Shape Memory Alloys. In: Sidorenko, A., Hahn, H. (eds) Functional Nanostructures and Sensors for CBRN Defence and Environmental Safety and Security, 105-112.

4. Osman Adiguzel (2018). Thermoelasticity, Superelasticity and Nanoscale Aspects of Structural Transformations in Shape Memory Alloys. In: Struble, L., Tebaldi, G. (eds) Materials for Sustainable Infrastructure, 287–293.

5. Osman Adiguzel (2018). Thermoelastic Phase Transformations and Microstructural Characterization of Shape Memory Alloys. In: Bonča, J., Kruchinin, S. (eds) Nanostructured Materials for the Detection of CBRN, 99-106

Biography

Osman Adiguzel graduated from the Department of Physics, Ankara University, Turkey in 1974 and received Ph.D.- degree from Dicle University, Diyarbakir-Turkey. He studied at Surrey University, Guildford, UK, as a post-doctoral research scientist from 1986 to 1987, and studied shape memory alloys. He worked as a research assistant, from 1975 to 1980, at Dicle University and shifted to Firat University, Elazig, Turkey in 1980. He became a professor in 1996, and he has been retired on November 28, 2019, due to the age limit of 67, following academic life of 45 years. He published over 80 papers in international and national journals; He joined over 120 conferences and symposia at the international and national level as a participant, invited speaker, or keynote speaker with contributions of oral or poster. He served as the program chair or conference chair/co-chair in some of these activities. In particular, he joined last six years (2014 - 2019) over 60 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. He supervised 5 Ph.D.- theses and 3 M. Sc- theses in his academic life. Also, he joined over 70 online conferences in the same way in the pandemic period of 2020-2021. Dr. Adiguzel served his directorate of the Graduate School of Natural and Applied Sciences, Firat University, from 1999-to 2004. He received a certificate awarded to him and his experimental group in recognition of the significant contribution of 2 patterns to the Powder Diffraction File – Release 2000. The ICDD (International Centre for Diffraction Data) also appreciates the cooperation of his group and interest in the Powder Diffraction File.

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