EuroSciCon Conference on
Nanotechnology & Smart Materials
October 04-06, 2018
Amsterdam, Netherlands

Nano Res Appl Volume:4
DOI: 10.21767/2471-9838-C6-025

SMART MATERIALS AND FUNCTIONAL CHARACTERIZATION OF SHAPE MEMORY ALLOYS

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Shape memory alloys take place in a class of adaptive structural materials called intelligent or smart materials by giving stimulus response to changes in the external conditions. These alloys exhibit dual characteristics, shape memory effect (SME) and superelasticity (SE) with the recoverability of two certain shapes at different conditions. These alloys are functional materials with these properties, and used as shape memory elements in many interdisciplinary fields such as medicine, pharmacy, bioengineering, metallurgy. This phenomenon is based on martensitic transformation, which is a solid state phase transformation and governed by the remarkable changes in internal crystalline structure of materials. Superelasticity is performed in only mechanical manner by stressing and releasing in the parent austenite phase region. Shape memory effect (SME) is performed thermally in a temperature interval depending on the forward (austenite —> martensite) and reverse (martensite —> austenite) transformation, on cooling and heating, whereas superelasticity is performed by stressing the material in the strain limit in the parent phase region and shape recovery is performed simultaneously upon releasing the applied stress. Shape memory effect is result of successive thermally and stress induced martensitic transformations, whereas superelasticity is the result of stress-induced martensitic transformation and performed in non-linear way, unlike normal elastic materials and exhibits rubber like behaviour. Loading and unloading paths are different in pseudo elasticity, and cycling loop reveals energy dissipation. The strain energy is stored after releasing and these alloys are mainly used as deformation absorbent materials in control of civil structures subjected to seismic events, due to the absorbance of strain energy during any disaster or earthquake. Thermal induced martensitic transformations occur on cooling with cooperative movement of atoms in <110> type directions by means of lattice invariant shears on a {110}-type plane of austenite matrix which is basal plane of martensite. Thermally induced martensite occurs as the twinned martensite on cooling, and the twinned structure turn into the detwinned martensite by means of stress induced martensitic by stressing material in the low temperature product phase condition. In the pseudoelasticity, material is deformed in the strain limits in a constant temperature in parent phase region, and parent phase structures turn into the detwinned structure by means of stress induced martensitic transformation by deformation. Copper based alloys exhibit this property in metastable beta-phase region. Lattice invariant shear is not uniform in copper based alloys and cause the formation of unusual complex layered structures. In the present contribution, X-ray diffraction and transmission electron microscopy (TEM) 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.

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