madridge CONFERENCES
International Conference on
Materials Science and Research
November 16-18, 2017 Dubai, UAE

Displacive Transformation and Twinned Nature of Product Structures in Shape Memory Alloys

O. Adiguzel
Firat University, Department of Physics, Turkey

Shape memory alloys have a peculiar property to return to a previously defined shape or dimension when they are subjected to variation of temperature. These alloys recover original shape on heating after deformation in low temperature product phase condition. Shape memory effect is facilitated by martensitic transformation governed by changes in the crystalline structure of the material, and shape memory properties are intimately related to the microstructures of the alloy. Thermal induced martensite occurs as multivariant martensite in self-accommodating manner on cooling from high temperature parent phase region, and this martensite is called self-accommodated martensite or multivariant martensite. Deformation of shape memory alloys in martensitic state proceeds through a martensite variant reorientation.

Martensitic transformations occur with cooperative movement of atoms by means of lattice invariant shears on a {110} - type plane of austenite matrix which is basal plane of martensite. The lattice invariant shears occurs, in two opposite directions, <110 > -type directions on the {110}-type basal plane. This kind of shear can be called as {110}<110> - type mode, and possible 24 martensite variants occur.

Martensitic transformation is a shear-dominant solid-state phase transformation, by which the ordered parent phase structures turn into complex layered structures. Martensitic structures occur as martensite variants in a self-accommodating manner through twinning Shape memory properties are intimately related to the microstructures of the material, especially orientation relationship between the various martensite variants. Twinning and detwinning processes can be considered as elementary processes activated during the transformation. In particular, the detwinning is essential as well as martensitic transformation in reversible shape memory effect. By applying external stress, the martensitic variants are forced to reorient into a single variant leading inelastic strains. Deformation of shape memory alloys in martensitic state proceeds through a martensite variant reorientation of twins.

Copper based alloys exhibit this property in metastable β-phase region, which has bcc-based structures at high temperature parent phase field, and these structures martensitically turn into layered complex structures with lattice twinning following two ordered reactions on cooling.

In the present contribution, x-ray diffraction and transmission electron microscopy (TEM) studies were carried out on two copper based alloys which have the chemical compositions in weight; Cu-26.1%Zn 4%Al and Cu-11%Al-6%Mn. 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.

Keywords: Shape memory effect, martensitic transformation, self-accommodation, twinning and detwinning, layered structures.