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PHYSICAL ASPECTS AND NANOSCALE CHARACTERIZATION OF PHASE TRANSFORMATIONS IN SHAPE MEMORY ALLOYS

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Shape memory effect is a peculiar property exhibited by series alloy systems in the β-phase fields. Successive martensitic transformations, thermal induced and stress induced martensitic transformations govern shape memory effect in shape memory alloys. Shape memory effect is performed thermally in a temperature interval on heating and cooling after deformation in low temperature phase condition. Thermal and stressing processes govern shape memory effect in physical basis; twinning and detwinning processes govern in crystallographic basis. Thermal induced martensitic transformation occurs as Martensite variants with lattice twinning in crystallographic scale. Twinned Martensite structures turn into detwinned Martensite structure by means of stress induced transformation Martensite variants occur with the cooperative movement of atoms by means of shear-like mechanism. 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 the complex stacking ordered structures with lattice twinning reaction on cooling. Lattice invariant shears are not uniform in copper based shape memory 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 close-packed planes, basal planes, exhibit high symmetry and short range order as parent phase. 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 microscope studies were carried out on two copper based CuZnAl and CuAlMn alloys. These alloy samples have been heat treated for homogenization in the β-phase fields. 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. In particular, some of the successive peak pairs providing a special relation between Miller indices come close each other and this result leads to the rearrangement of atoms in diffusive manner.

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