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Microstructural aspects of phase transformations in shape memory alloys

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Shape memory alloys take place in a class of functional and smart material, due to the stimulus response to environment by exhibiting a peculiar property called shape memory effect. This property is characterized by the recoverability of two certain shapes of material at different conditions. Shape memory effect is governed by microstructural changes by means of a structural transformation, called martensitic transformation, which is a first order lattice-distorting phase transition, and occurs with cooperative movements of atoms by means of shear-like mechanism on cooling from high temperature parent phase region. Martensitic transformation occurs as martensite variants in self-accommodated manner with lattice invariant shears which occur in <110> -type opposite directions on the {110}-type planes of austenite matrix. The basic processes are the twinning and detwinning in shape memory alloys. Thermal induced martensite occurs as twinned martensite, and the twinned structures turn into the oriented structures by deforming the material in the martensitic condition. Deformation of shape memory alloys in martensitic state proceeds through a martensite variant reorientation. The deformed material recovers the original shape on heating over the austenite finish temperature, and cycles between the deformed and original shapes on cooling and heating, respectively, whereas the crystal structure cycles between the twinned and ordered parent phase structures. Microstructural mechanisms responsible for the shape memory effect are the twinning and orientation processes. Therefore, the twinning and orientation processes have great importance in the shape memory behaviour of the materials. 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 martensiticaly turn into layered complex structures with lattice twinning following two ordered reactions on cooling. Lattice twinning and lattice invariant shears occur in non-uniform way in copper based shape memory alloys, and this process causes to the formation of the long periodic complex layered structures. In the present contribution, x-ray diffraction, transmission electron microscope and differential scanning calorimeter (DSC) studies were carried out on two copper based ternary alloys. The x-ray diffractograms taken in a long time intervals from the aged specimens at room temperature reveal the structural changes in diffusive manner.