s5.m17.p1 Crystallography of Microstructural Transitions in Copper Based Shape Memory Alloys.

O. Adigüzel, *Firat University, Department of Physics, 23169, Elazig/Turkey. E-mail: oadiguzel@firat.edu.tr*

Keywords: Shape memory effect; Martensite; Layered structures

The behaviour of some materials is evaluated by the structural changes in microscopic scale. Shape-memory alloys are a typical class of such materials, which have the modified crystal structures in the transformed case and exhibit a peculiar property called shape memory effect. A series of copper based alloys and nearly equiatomic NiTi alloys exhibit this peculiar property which involves the repeated recovery of macroscopic shape of material in β(bcc) phase region. Metastable β-phases of noble metal copper based ternary alloys are very sensitive to the heat treatments and transform from the B2(CsCl) or DO$_3$(Fe$_3$Al) type ordered structures to the multilayered structures in martensitic manner on cooling. In case these alloys are deformed in a temperature range in martensitic condition they change in shape and recover the undeformed original austenitic shape on heating over the reverse transition temperature after removing the strain. These materials regain the deformed shape on cooling to the martensitic state and cycle between deformed and undeformed shapes on cooling and heating. Therefore this property is called reversible shape memory effect.

Martensitic transformations in shape memory alloys occur by two or more lattice invariant shears on a $\{110\}_\beta$ plane of parent phase called basal plane of martensite. The order of martensite structure is closely related to the order of parent due to the diffusionless character of the transformation, and the martensite exhibits the order of parent existing prior to the transformation. Martensite phase has the unusual layered structures which consist of an array of close-packed planes with complicated stacking sequences called as 3R, 9R or 18R martensites depending on the stacking sequences on the close-packed planes of the ordered lattice. On the basis of austenite-martensite relation, it is experimentally determined that the basal plane of 9R (or 18R) martensites originates from one of the $\{110\}_\beta$ planes of the parent phase, and an homogenous shear occurs on the basal plane in either of two opposite directions during the transformation.

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s5.m17.p2 The KOSSEL and the X-ray Rotation-Tilt Technique - further applications in material science.

Jürgen Bauch, Marian Böhling, Hans-Jürgen Ullrich, *TU Dresden, Institut für Werkstoffwissenschaft, Germany. E-mail: bauch@rcs.urz.tu-dresden.de*

Keywords: X-ray microdiffraction; KOSSEL technique; X-ray rotation-tilt technique

The KOSSEL technique [1], [2], [6] is a special X-ray micro-diffraction method where local X-rays are produced by directing a finely focused electron beam or collimated synchrotron rays (Ø < 10 µm and 100 µm, respectively) on a single crystal sample. The radiation of the characteristic and continuous spectrum in case of electron excitation leaves the crystal undiffracted and gives rise to the undesired background blackening of the detector (X-ray film, image plate or - with restrictions - CCD camera). Only very few of the characteristic rays, which satisfy the BRAGG law, reinforce each other and cause diffraction. These interferences are situated on a cone with the half opening angle equal to $90°$-Θ_{hkl} and create the so-called KOSSEL lines on the X-ray film located on the back.

The XRT technique [3]…[7] is another special X-ray microdiffraction method where local X-ray interferences are produced by directing an X-ray or synchrotron beam from an external source with monochromatic radiation of high intensity and a small diameter (e.g. application of capillary optics) onto a crystalline region of a sample. Thereby, for each diffracting lattice plane a cone can be indicated with the half-opening angle equal to $90°$-Θ_{hkl} for which the BRAGG equation is satisfied. Each time the incident monochromatic X-ray beam coincides with a shell line of the interference cone on the diametrically opposite side of the cone shell, a small spot is produced by the "reflected" beam. By moving the sample in a special way it is possible to accumulate such cones spot by spot on a detector system (e.g. film, image plate, or CCD-area-detector) which is located on the back. Therefore, this techniques can be applied to a wide range of analytical problems in materials diagnostics, e.g. high-accuracy determination of crystallographic orientations, high-accuracy determination of lattice constants, dislocation density determination, determination of decrease in symmetry, precision determination of stress/strain and phase identification in micro regions. This will be demonstrated by some selected examples of new applications of functional materials.

Further on, a completely new multifunctional microdiffraction system will be introduced, which combines the KOSSEL and EBSD technique in one SEM. Therefore, a higher lateral resolution (Ø up to 1 µm) for the X-ray diffraction method is enabled.

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