P17.04.10

Acta Cryst. (2008). A**64**, C600

Diffraction studies of an Al-Zn-Mg single crystal by synchrotron radiation

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Precipitation of phases from a supersaturated solid solution is an important process in materials technology. Precursors for the precipitates are local structures in the solid solution and partially ordered Guinier-Preston zones. Within the ternary alloy system Al-Zn-Mg, intermediate structures are recognized according to the precipitation sequence: *Supersaturated solid solution --> zones --> η'-precipitates --> η -MgZn*$_2$ The embedded *η'*-precipitates are disc-shaped with a diameter in the order of 100 Å and a thickness of approximately 30 Å. The particles exhibit well-defined orientation relationships to the Al-matrix. Although their unit cell is known, their structure is still not finally determined. One experimental challenge is to measure the very strong Al-matrix reflections together with the much weaker diffracted intensities from the precipitates. This is however partly overcome by transforming the UB-matrix of the Al-lattice using the orientation relationships of the *η'*-particles. Thus individual UB-matrices for every of the four principal precipitate orientations are obtained. Accurate intensity profiles may then be recorded using a point detector, in combination with CCD-data. A single crystal grain from a previously heat-treated polycrystalline sample of composition $Al_{0.88}Zn_{0.10}Mg_{0.02}$ was investigated using the KM-6 single crystal diffractometer at the Swiss-Norwegian Beamlines (SNBL) at the ESRF. Using the method of UB-matrix transformations, four data sets from the *η'* particles have been successfully collected with a YAP-point detector. It was possible to obtain diffraction profiles up to 60° in 2θ using a wavelength of 0.7 Å. Owing to reflection overlap, each profile out of the 4216 must be individually treated in the subsequent reduction- and solution process.

Keywords: synchrotron radiation crystallography, synchrotron diffraction, single-crystal X-ray diffraction

P17.04.11

Acta Cryst. (2008). A**64**, C600

X-ray study of langasite: Composition, crystal structure and microstructure

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Langasite ($La_3Ga_5SiO_{14}$) is one of the most promising materials for making both bulk acoustic and surface acoustic waves devices. However the physical properties of crystals may vary axially and radially. The aim of this paper is to determine the reasons of these changes. A number of plates 8mm in diameter and 0.097 mm thick were cut out from a langasite crystal ($La_3Ga_5SiO_{14}$, Czochralski method, growth axe <0001>) in the directions perpendicular to <01-10> (plates 1,2,3) and perpendicular to <0001> (plate 4). The plate 5 was cut out perpendicular the growth axe (<01-11>) from the crystal with the same nominal composition. The plates ground into powder were examined by X-ray diffraction on HZG-4A diffractometer. X-ray study of the microparts was carried out on CAD-4 diffractometer. Measurement of the elastic properties was realized in the device of amplitude-frequency characteristics measurement X1-54. Study of the plates microstructure (blocks disorientation and rocking curves) was accomplished on D8 Discover difractometer. As shown by the results of microstructure study the most defected are plates 1, 2 and 3: plate 1 has maximal disorientation of blocks (max~0.22 o), plate 3 has minimal one (mac~0.07 o). Study of elastic properties showed that plate 3 (refined composition La$_3$(Ga3.960□0.040(9))(Ga1.11Si0.89(1))(O13.89□0.11)) has higher frequency and elastic coefficients in comparison with plates 1 and 2. These properties depend mainly on microstructure of samples. The comparison of rocking curves achieved that plate 5 is more perfect than plate 4. Analysis of ours and literature [1] data allowed to conclude that samples of X and Y-cuts are more perfect than plate of Z-cut (plate 4) with the same growth direction (<0001>).

1.Roshchupkin D.V.at all.2004

Keywords: piezoelectrics, microstructure analysis, X-ray diffraction

P18.04.01

Acta Cryst. (2008). A**64**, C600

Crystallography of layered structures of martensite in copper based shape memory alloys

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Shape memory effect is an unusual property exhibited by certain alloy systems, and leads to martensitic transition. At high-temperatures, these alloys possess simple bcc-structures in beta phase field, austenite structure. As temperature is lowered the austenite undergoes martensitic transition following two ordered reaction, and microstructural changes in microscopic scale govern this transition. The formation and evolution of the layered microstructures in copper based beta phase alloys consist of shears and shear mechanism. Martensitic transformations are first order diffusionless transitions and occur in a few steps. First one is Bain distortion, and the second one is lattice invariant shears which occur in either of two opposite directions, <110 >-type directions on a {110}-type plane of austenite matrix which is basal plane or stacking plane of martensite. This kind of shear gives rise to the formation of layered structure. Product phase in this transition has the unusual layered structures which consist of an array of close-packed planes with complicated stacking sequences called as 3R, 9R or 18R structures depending on the stacking sequences on {110}-type planes of matrix. If these alloys are deformed in martensitic condition, they keep the deformed shape, when the stress is removed, and furthermore, the deformation disappears and the material spontaneously returns to the original phase on heating over the austenite finish temperature. These alloys are also called thermoelastic materials due to this behaviour. In the present contribution, x-ray diffraction and transmission electron microscopy studies were carried out on two copper based alloys which have the following alloy compositions in weight, respectively; Cu-26.1%Zn 4%Al and Cu-11%Al-6%Mn.

Keywords: martensitic transition, shape memory effect, layered structures