Characterization of MgCa-bone screws by high energy texture analysis

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Introduction

In medical technology calcium containing magnesium alloys (MgCa) are promising to replace degradable polymers or titanium as the material for small bone screws or other fixating tools. To find the best composition of Mg and Ca and the best manufacturing process, it is essential to analyse the physical and chemical properties of many series of different magnesium alloys.

The physical properties of polycrystalline materials depend on the physical properties of the crystallites of which they consist and on the orientation of the crystallites in the polycrystalline aggregate [1,2]. Hence, it is necessary to determine the orientation distribution (texture) of the crystallites. Diffraction with high energy synchrotron radiation is a new experimental method for non-destructive texture measurements. The new GKSS materials science beamline HARWI II (W2) offers an opportunity to do texture measurements in an energy range of 20 - 200 keV.

Experimental Procedure

For the first experiments on this topic, we select a MgCa-bone screw with a composition of 99.6 wt % Mg and 0.4 wt % Ca. The magnesium alloy was extruded and thread was produced by machining. For the texture measurement with high energy synchrotron radiation [3], the MgCa screw was mounted on the Eulerian cradle with a z-translation on the sample tower. Diffraction images were taken in steps of $\Delta\varphi = 5°$ with a MAR345 image plate detector. The exposure time to require a diffraction image was 30sec and the beam size was adjusted to 2*2mm. Using a special software designed for the HARWI-beamline the pole figure data were calculated from the diffraction images.

Results

For the first experiment, the measured (100)-pole figure at three different positions at the bone screw are presented in figure 1. At each measuring point (P1-P3, fig. 1) a fibre texture was investigated. The fibre axis for the (100)-reflex is parallel to the screw axis. No significant variation in intensity and orientation of the observed texture could be observed for the acquired pole figures.

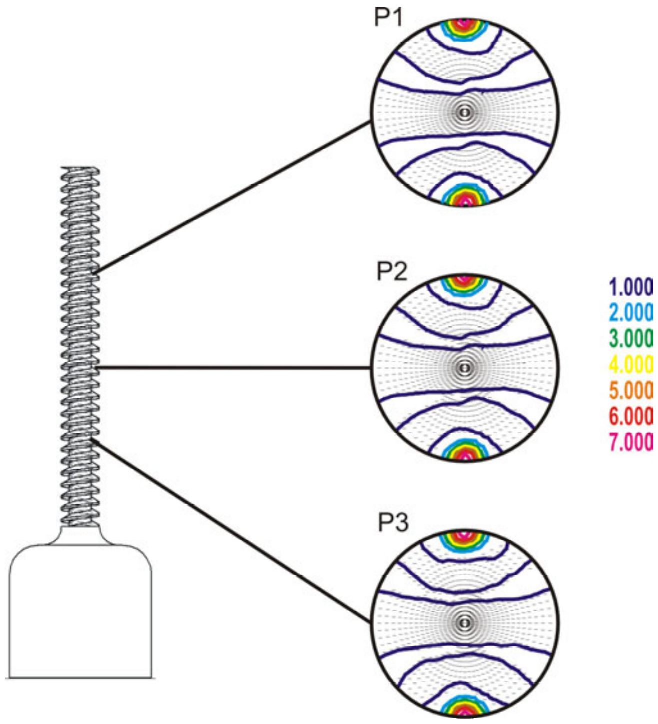

Figure 1: (100)-pole figures at different measuring points of a MgCa-bone screw.

Conclusions

Texture analysis with high energy synchrotron radiation at the new GKSS-beamline HARWI II (W2) is an excellent method to determine the homogeneity of texture with local texture measurement. The variable beam size up 100mm*5mm will allow also the investigation of the global texture in further experiments with the same beamline. The new HARWI II beamline allows to combine diffraction experiments and tomographic research at the same beamline after a short modification of the set-up. This new set-up at HARWI II provides the ability for extensive characterisation of MgCa-bone screws and other materials used in medical technology.

References

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