Microstructure analysis of Al(MnCu) samples

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Due to the versatility, easy processing, and the multitude of applications of metals, an important number of research centres join their efforts seeking to improve the properties of this type of materials. Among the different mechanisms for improving mechanical properties, grain refinement achieved using severe plastic deformation (SPD) methods has been shown to be effective in increasing simultaneously the strength and toughness of the materials. A new method capable to produce ultra-fine grained tubular samples from bulk billets in one single step [1] has been employed to produce $Al_{0.98}(Cu, Mn)_{0.02}$ cylinders.

X-Ray measurements were performed on the lateral surface of the cylinder (see Fig.1a) carried out using Co Kα radiation with a point focus and Bragg-Brentano (theta/2theta) geometry. Following Rietveld refinement analysis was made providing a mean volume-weighted crystallite size Lvol-IB=248 nm with a microstrain of about 2%.

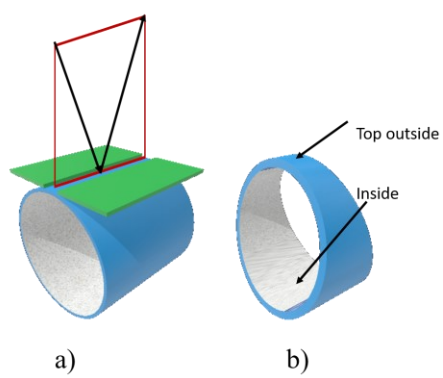

Figure 1: setup for the X-ray measurements with the employed nomenclature

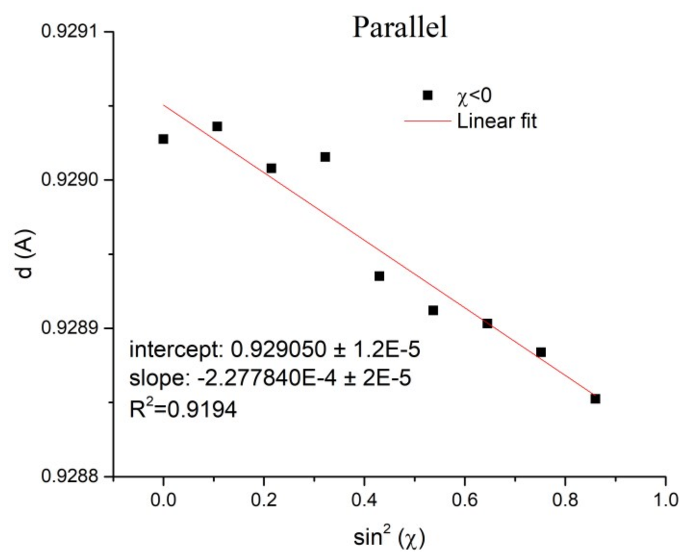

Figure 2: $\sin^2 \chi$ plot for the interplanar distance of planes (133) for the situation depicted in Fig. 1a)

Then the sample was cut in order to make residual stress measurements on both outer and inner surfaces of the cylinder (see Fig. 1b). The $\sin^2 \chi$ plot method [2], [3] has been used to evaluate the macroscopic residual strain of the sample which value is proportional to the observed slope. The measurements have been taken using Co Kα radiation and a graded multilayer mirror (Göbel mirror). The reflection from the plane (133) found at 2theta=148.65 degrees was selected for this study. The measurements have been performed using a geometry in pseudo inclination mode (measuring at different ω angles) at two different phi positions: with the diffraction plane placed along the axis of the cylinder (Fig 1a) and perpendicular to it. The measured diffraction peaks were fitted with asymmetric pseudo-Voigth functions in order to determine the position of the intensity maximum. In Fig.2 is shown one of the $\sin^2 \chi$ plot used in this study where can be appreciated the small slope from which a compressive stress in the order of tens of MPa has been calculated. This is a small value compared with other metals as steals which have values one order of magnitude higher.

Figure 3 shows the results obtained from the 3 different measurement conditions considered in this study

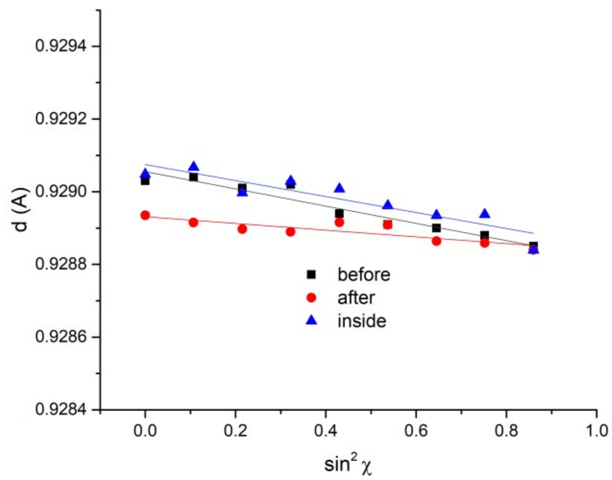

Figure 3: $\sin^2 \chi$ plot for the interplanar distance of planes (133) measured in all the 3 different conditions

It is noticeable that the cutting induce some relaxation of the residual stress while very small difference was observed between the outer and inner surfaces being the stress slightly smaller in the inner part.

Further investigations will be performed in order to determine the stress gradient along the wall of the cylinder.

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