Chair of Metal Forming and Casting
TUM School of Engineering and Design
Technical University of Munich

Equal Channel Angular Pressing (ECAP)

Reduction of the plastic anisotropy of magnesium materials

Motivation

With a density of 1.74 g/cm³, magnesium has a high value as a lightweight material. However, magnesium and magnesium alloys crystallize in a hexagonal close-packed (hcp) crystal structure. In this lattice type, only three slip systems exist. This means that Mg materials have an intrinsic disadvantage in terms of formability compared with Al or Fe materials, whose cubic crystal lattices each offer 12 slip systems. In addition, the crystallites in Mg sheets exhibit a preferred direction due to the rolling process. This so-called texture leads to anisotropic material properties and additionally limits the forming capacity.

Due to the poor flow behavior of rolled Mg sheets, they are used in industry only in niche areas. Nevertheless, these materials have great potential with regard to lightweight construction applications.

If the forming capacity of rolled magnesium sheets can be increased, these sheets could be used in a wide range of industrial applications.

Goals

This is precisely the research question that *utg* and the *Helmholtz Center Hereon* are jointly pursuing as part of a cooperative project. With an ECAP tool, shown in figure 1, shear strains can be selectively introduced into Mg sheets so that plastic deformations remain in them. This results in a rearrangement and intermixing of the individual crystallites. This realignment of the grains reduces the texture pronounced by the rolling process, which is accompanied by a reduction in the anisotropy of the material.

Figure 1: ECAP tool; a sheet blank is pressed through an angled channel to selectively modify the microstructure of the sheet.

In addition to anisotropy reduction, the ECAP process also leads to grain refinement. In Figure 2, the textures of a Mg sheet can be compared before and after treatment by an ECAP process. The finer-grained microstructure means both an improvement in the mechanical properties and an improvement in the formability of the Mg sheet.

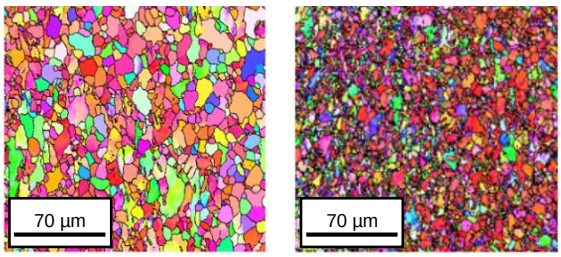

Figure 2: Microstructure of a Mg-ZEW alloy before (left) and after (right) treatment by an ECAP process.

Viktor Böhm, M.Sc.
Walther-Meissner-Str. 4
85748 Garching

Tel. +49 89 289 14 533
viktor.boehm@tum.de
www.utg.mw.tum.de

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