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The Influence of Foils Thickness on Recrystallized Structure Observed during *In-Situ* Heating of AlMgScZr Alloy

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AlMg-based alloys exhibit excellent corrosion resistance. Nevertheless, one of their primary disadvantages is their lower strengths for structural applications. Additions of scandium and zirconium offer attractive combination of properties. The precipitation of metastable $Al_3(Sc,Zr)$ particles during aging delivers contribution from precipitation hardening increasing thus the strength levels of the alloy.

Twin-roll casting (TRC) of such alloys is not a standard procedure but it enables to cast strips with a final thickness equal to the requested one. The microstructure formed during this type of casting contains nearly equiaxed grains [1] that are less susceptible to exfoliation corrosion than flat elongated grains appearing in conventionally cast and rolled materials [2]. This susceptibility is predominantly linked to the precipitation of highly anodic Al_3Mg_2 phase along flat grain boundaries [3]. Therefore, new approaches of aluminum sheets production are in the center of an intensive research now. TRC is a promising option which does not produce an undesirable fiber structure [4], and moreover could be combined with several methods of severe plastic deformation (SPD) in order to reach further grain refinement and strengthening [5] of the final metal strip.

The evolution of microhardness during annealing at elevated temperatures was studied in a TRC Al-3.24 % Mg-0.19 % Sc-0.14 % Zr (wt.%) alloy with small additions of Fe, Mn and Si as impurities. The material was predeformed by four cycles of equal channel angular pressing (ECAP) at 250 °C using the route B_c [6]. Mechanical properties were related to electron microscopy microstructure observations including *in-situ* heating in the transmission electron microscope (TEM).

In accordance with recent results an increase of microhardness occurs during annealing up to 300 °C (Fig. 1a) due to the formation of a fine dispersion of $Al_3(Sc,Zr)$ particles (Fig. 1b). A two-stage drop of microhardness observed above this temperature is associated with the coarsening and growth of strengthening $Al_3(Sc,Zr)$ particles and recovery and recrystallization of the deformation structure (Fig. 2a). However, the final grain size observed by TEM during the *in-situ* heating at highest annealing temperatures was by an order of magnitude smaller than the one generally detected in bulk specimens annealed in a furnace (Fig. 2b).

Electron back scatter diffraction (EBSD) analysis was performed on the *in-situ* annealed TEM foil (Fig. 3a). Clear distribution of the grain size reflecting the wedge-shape of the foil near the hole in the center of the specimen (Fig. 3b) confirms the negative constraining role of the foil thickness. The grain size near the edge of the hole (area, where the *in-situ* TEM study was performed) does not exceed several micrometers while in thicker zones of the specimen (generally around 100 μm thick) the diameters of grains easily approach several hundreds of micrometers which is the size comparable with the grain diameters observed in bulk specimens. The obtained results clearly indicate the limitation of *in-situ* experiments to objects of scales not exceeding the thickness of the foil. [7]

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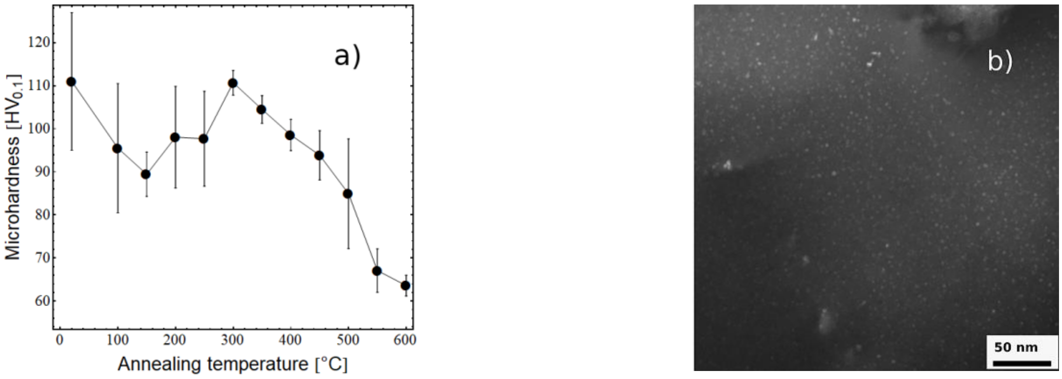

Figure 1. Evolution of microhardness of TRC AlMgScZr alloy predeformed by ECAP during isochronal annealing with the step 50 °C/ 50 min (a) and distribution of fine $Al_3(Sc,Zr)$ precipitates after annealing to 300 °C (b).

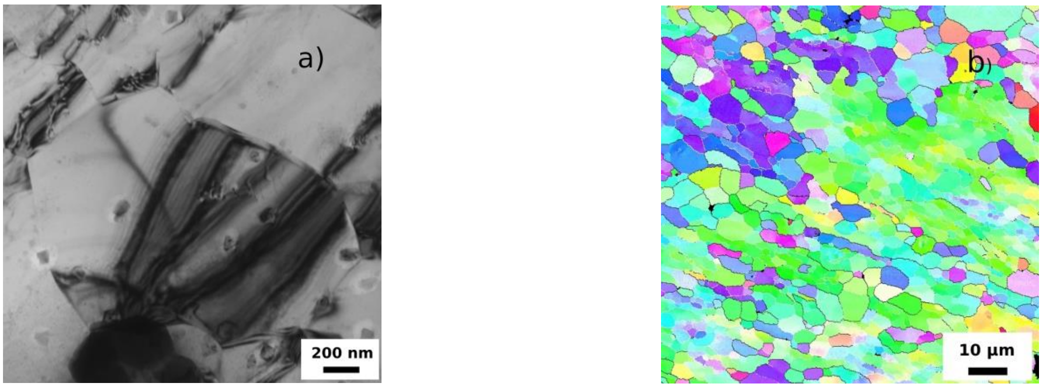

Figure 2. TEM image of grains in TRC AlMgScZr alloy annealed *in-situ* up to 550 °C (a) and EBSD map of grains in the bulk specimen annealed up to the same temperature (b).

Figure 3. Area selected on a TEM specimen for EBSD analysis (a) and corresponding EBSD map (b).

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