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Grain boundary wetting in the Al–Zn and Al–Mg alloys

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In this work the differential scanning calorimetry (DSC) investigation of grain boundary (GB) wetting phase transition in the Al–Zn and Al–Mg alloys before and after high pressure torsion (HPT) has been studied. In Fig.1 and 2 DSC curves for both as-cast coarse-grained and fine-grained HPT-samples for investigated alloys are shown. The shape of melting curves is asymmetric (they have "shoulders"). It was supposed that this two-stage melting is due to the transition from incomplete to complete wetting of GBs by the melt.

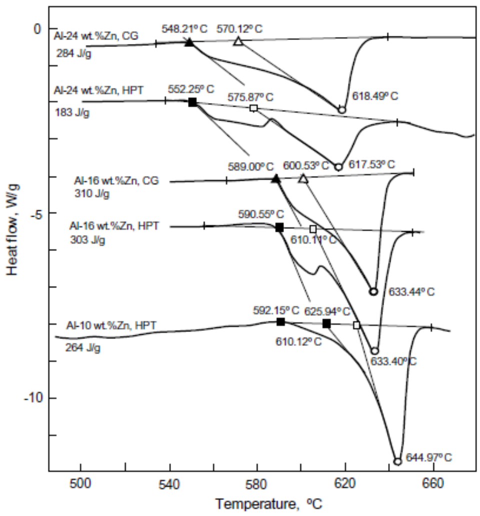

Figure 1: Temperature dependence of heat flow (DSC curves) for the Al–Zn samples. ○ – liquidus temperature, Δ – bulk solidus for coarse-grained alloys, □ – bulk solidus for fine-grained (HPT) alloys, ▲ – GB solidus for coarse-grained alloys, ■ – GB solidus for fine-grained (HPT) alloys.

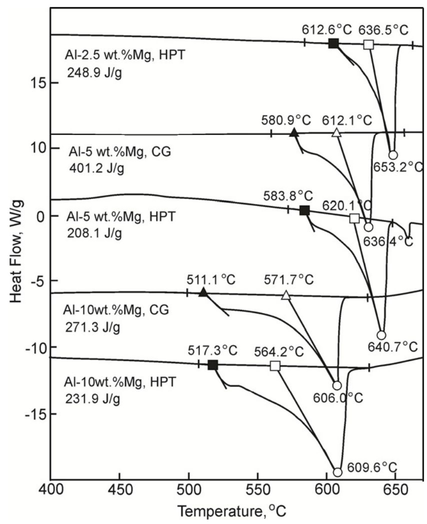

Figure 2: Temperature dependence of heat flow (DSC curves) for the Al–Mg samples: ○ – liquidus temperature; ▲– incomplete wetting of GB for coarse-grained alloys; ■ – incomplete wetting of GB for fine-grained (HPT) alloys; Δ – complete wetting of GB for coarse-grained alloys; □ – complete wetting of GB for fine-grained (HPT) alloys.

In Al–Zn alloys after HPT we observed that the melting starts ~10–25 °C below the bulk solidus line. It means that between GB solidus (premelting) line and bulk solidus the GB contains the layer of a liquid-like phase. Such layers could ensure the extremely high superplasticity of Al-based alloys just below the bulk solidus line [1]. In the contrast to the Al–Zn alloys, the GB solidus line for Al–Mg alloys after HPT is very close to the bulk solidus. The difference between them does not exceed 2 °C. It means that, most probably, the addition of magnesium to the Al-based alloys makes the area between GB and bulk solidus narrower.

References

[1] B. Straumal, G. López, W. Gust, et al., Effect of the grain boundary phase transitions on the superplasticity in the Al–Zn system, in: M.J. Zehetbauer, R.Z. Valiev (Eds.), Nanomaterials by Severe Plastic Deformation: Fundamentals, Processing, Applications, John Wiley, VCH, Weinheim, 2004, pp. 642–647.