Phase transformation of second phase intermetallics in AA6xxx during homogenization

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Introduction and objectives

The second phase intermetallics in AA6xxx transform during homogenization. It is important to investigate this transformation because the intermetallic phase, morphology and distribution influence the extrusion properties of the material considerably.

The transformations in AA6005 have been investigated by SEM and Energy Dispersive Spectrography (EDS). A start has been made to isolate the intermetallics from the aluminium matrix by the SIBUT extraction method.

Results

Samples of AA6005 are homogenized for 1, 2, 4, 8, 16 and 32 hours at 540 °C, water quenched, and polished. SEM images of the samples (Figure 1) show the change in morphology of the intermetallics from platelike to more rounded particles. This change in morphology is also reported in literature for intermetallics in AA6061 and AA6063.

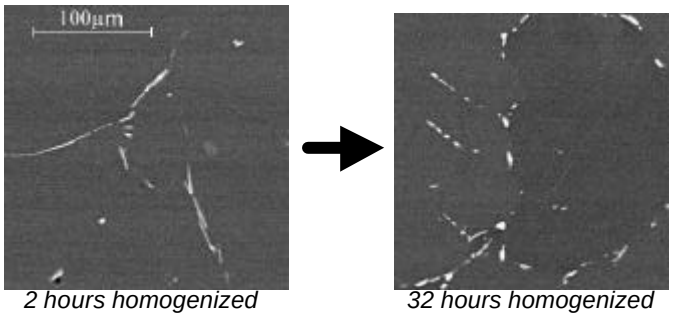

Figure 1. SEM images of intermetallics in AA6005 .

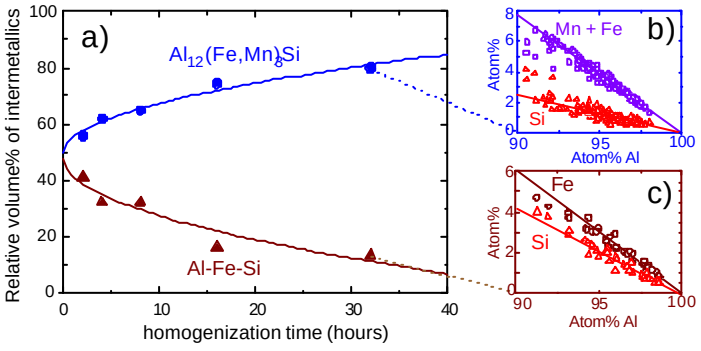

Figure 2. EDS measurements of phase transformation. a) Change of relative volume of two main type of intermetallics as function of the homogenization time. b and c) EDS measurements of $Al_{12}(Fe_x,Mn_{1-x})_3Si$ and Al-Fe-Si particles in a 32 hours homogenized sample.

The chemical composition of the intermetallics were measured by EDS. Two main types of intermetallic are found: the α-$Al_{12}(Fe_x,Mn_{1-x})_3Si$ and Al-Fe-Si. (Other phases were Al-Mn-Si, Al-Fe and Al-Mn; however, their relative volume fraction was $\leqq$ 7% of measured population in all samples.) During homogenization a phase transformation is observed from Al-Fe-Si to $Al_{12}(Fe,Mn)_3Si$, as indicated in Figure 2.

The SIBUT method is a chemical technique which dissolves the aluminium matrix, after which the residue of intermetallic particles are filtered out. SEM images were made of the intermetallic skeleton from an AA6005 as-cast material (Figure 3), where it can be seen that the as-cast intermetallics have a thin platelike shape.

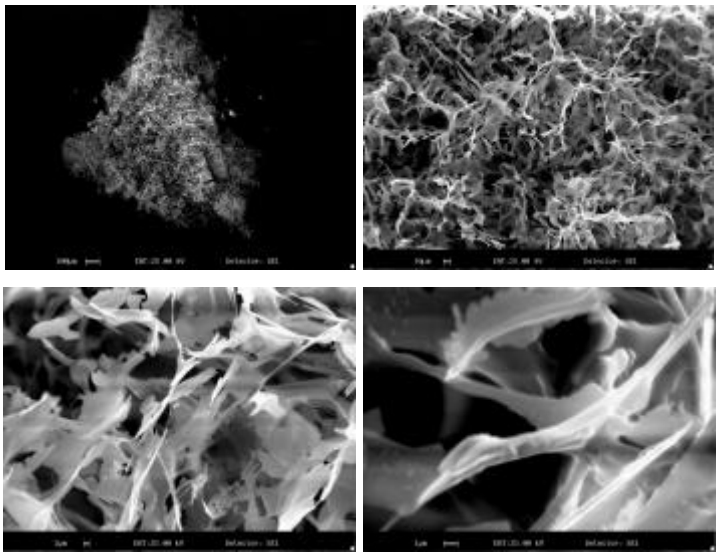

Figure 3. SEM images of the intermetallic skeleton.

Conclusion and future work

Phase and morphology changes can be observed quantitatively by SEM and EDS. The SEM images of the SIBUT intermetallics look promising, without any artifacts, and therefore extraction by the SIBUT method will be continued. X-ray analyses of the extracted particles will be performed, which will distinguish the α- and β-type of Al-Fe-Si phases.

New measurements will be performed on samples with higher homogenization temperatures to look at the temperature dependence of the transformation. Measurements on AA6063 will also be performed. This alloy may give different phase transformations and morphology changes in the intermetallics.

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