Structure of Al-TM-Ce alloy

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Introduction

Rapid solidification is one of few possible methods for preparing thermally stable aluminium alloys. The structure of such alloys is very fine (with average grain size about 1 μm and even smaller intermetallic particles with size of few hundreds nm [1]). This means, the only suitable method for observing these materials is transmission electron microscopy (TEM). On the other hand this method needs very special samples: thin foils or extremely small pieces of material prepared by selective dissolution of materials matrix. The choice between these two types of samples depends on information, which is wanted to be obtained. For summary view of material it is necessary to use for observing a thin foils but for more detail information about present intermetallic phases it is advantageous to prepare samples by selective dissolution of rapidly solidified ribbons.

The aim of this paper was to prove the possibility of selective dissolution reagent utilization for investigation of Al-TM-Ce based alloy.

Experiment

An alloy with composition of Al-5.5 wt. % Cr-3 wt. % Fe-1.5wt. %Ti-3 wt. % Ce was prepared by melting appropriate amounts of master alloys and pure metals (Al-11wt.% Cr, Al-4wt.% Ti, Al, Fe and Ce) in induction furnace. Consequently, rapidly solidified ribbons were prepared by melt spinning at cooling wheel circumferential speed of 28 m/s. Thin foils, the TEM samples, were prepared by grinding and etching in solution containing $C_2H_5OH:HNO_3$ equal to 3:1 under following conditions: 10 V and -20°C. Intermetallic phases were extracted from rapidly solidified ribbons by selective dissolving of fcc-Al in solution of 250g methanol, 25g tartaric acid and 10g iodine [2]. TEM observing was performed on Jeol 3010 at accelerating voltage 300 kV. Phase composition of all materials was determined by X-Ray diffraction (XRD) on PAN analytical X'Pert PRO + High Score Plus.

Results, discussion and conclusion

According to XRD pattern given in Figure 1, the rapidly solidified material consists of fcc-Al, $Al_{13}Cr_2$, $Al_{80}(Cr,Fe)_{20}$, Al_3Ti and Al_2Ce. During aluminium matrix dissolution, Ce containing phases are also affected and a new amorphous phase is formed, as it is documented in Figure 1 and Figure 2. So in contrast to Al-TM alloys, the A-TM-Ce alloy can be observed by TEM only in thin foils form, as shows Figure 3 or another selective dissolution reagent should be found.

1. D. Vojtěch et al., J. of Alloys Compounds 475 (2009) p151
2. Bartova B. et al., J. of Alloys Compounds 387 (2005) p193
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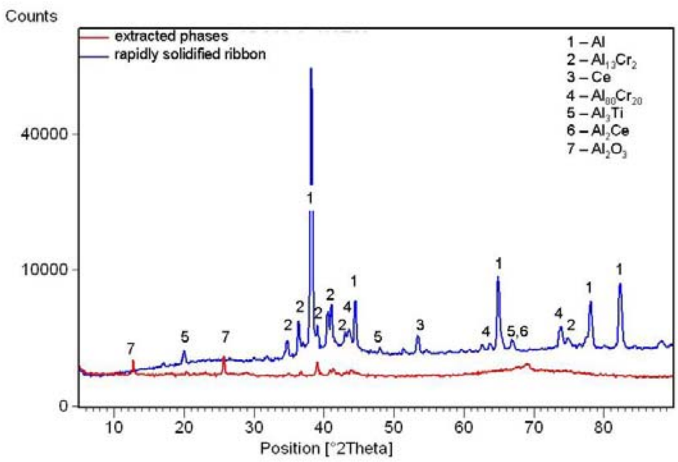

Figure 1. XRD patterns of rapidly solidified ribbon and extracted phases from AlCr5.5Fe3Ti1.5Ce3 alloy showing the change in phase composition during selective dissolution of Al matrix

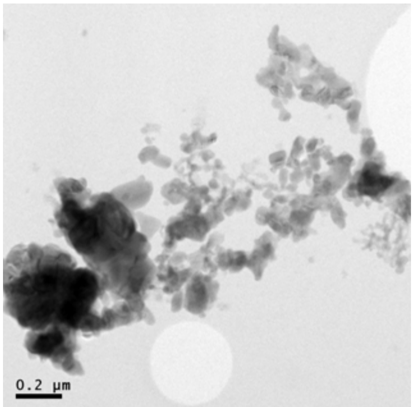

Figure 2. Structure of extracted phases from AlCr5.5Fe3Ti1.5Ce3 alloy

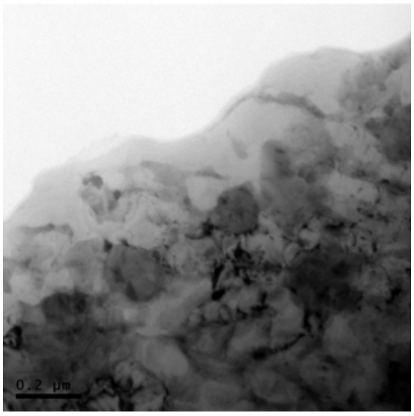

Figure 3. Structure of AlCr5.5Fe3Ti1.5Ce3 rapidly solidified ribbon