ICAM2009
11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

β phase formation in the Cu-11wt.%Al alloy with Ag additions

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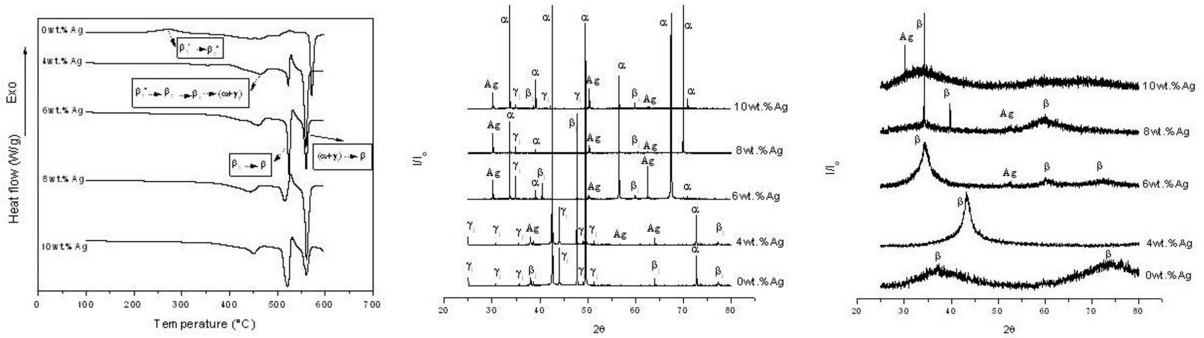
Abstract - In this work, the influence of Ag additions on the formation of the β phase in the Cu-11wt.%Al alloy was studied using differential scanning calorimetry (DSC) and in situ X-ray diffraction (XRD). The results indicate the presence of very small crystals of the β phase and the detection of the β phase formed from two different reaction routes, $\beta_1 \rightarrow \beta$ and $(\alpha + \gamma_1) \rightarrow \beta$. The formation of very small crystals of the β phase may be related with the structure of the α and γ_1 phases and also with the presence of a large amount of α –Cu solute.

The Cu-11wt.%Al alloy is among those showing a martensitic transformation on rapid cooling from the high temperature β phase. During the heating of the β_1' martensitic phase a reverse martensitic transformation $\beta_1' \rightarrow \beta_1$ occurs and, after slow heating, part of the β_1 phase transforms into the eutectoid $(\alpha + \gamma_1)$ complex phase. The β_1 phase remnant part gives the $\beta_1 \rightarrow \beta$ reaction. Heating of the complex phase from 565 ^{o}C gives the $(\alpha + \gamma_1) \rightarrow \beta$ reaction [1]. In this work, the influence of Ag additions on the formation of the β phase in the Cu-11wt.%Al alloy was studied using differential scanning calorimetry (DSC) and in situ X-ray diffraction (XRD). The samples were quenched from 900 ^{o}C in iced water to obtain the martensitic phase and results from DSC (figure 1-a) showed an increase in the peak corresponding to the $\beta_1 \rightarrow \beta$ reaction and a decrease in that corresponding to the $(\alpha + \gamma_1) \rightarrow \beta$ reaction with the increase in Ag concentration, indicating that Ag additions are decreasing the $\beta_1 \rightarrow (\alpha + \gamma_1)$ reaction rate and increasing the β_1 relative fraction available for the $\beta_1 \rightarrow \beta$ reaction. In situ X-ray diffraction patterns confirmed what was proposed in the discussion of the DSC curves (figure 1-b) and showed the presence of enlarged peaks together with normal peaks both corresponding to the β phase (figure 1-c). These results seem to indicate the presence of very small crystals of the β phase which are responsible for the peak enlargement, and the possible detection of the β phase formed from the two different routes, $\beta_1 \rightarrow \beta$ and $(\alpha + \gamma_1) \rightarrow \beta$.The formation of very small crystals of the β phase in the Cu-11wt.%Al alloy may be related with the structure of the α and γ_1 phases and also with the presence of a large amount of α –Cu solute. Due to this large amount of solute and to the misfit of the crystallites of the reacting phases (α and γ_1) the formed grain boundaries may be saturated with α –Cu and, as expected from the alloy concentration, there are more Cu than Al atoms in the system and a great number of β nuclei may be formed but will be enveloped by the Cu-rich solute, thus isolating these nuclei and impeding them from growing. In this way, the large X-ray diffraction peaks may be associated with the $(\alpha + \gamma_1) \rightarrow \beta$ reaction and the normal ones with the $\beta_1 \rightarrow \beta$ reaction.



(a) (b) (c)

Figure 1 : (a) DSC curves obtained for the studied alloys initially quenched from 900 ^{o}C, with a heating rate of 10 ^{o}Cmin^{-1}. (b) X-ray diffraction patterns obtained for the studied alloys initially quenched from 450 ^{o}C and (c) 750 ^{o}C.

Reference

[1] J. Kwarciak, J. Therm. Anal. 31 (1986) 559-566.