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

Effect of Ag additions on the martensitic phase aging kinetics in the Cu-11wt.%Al

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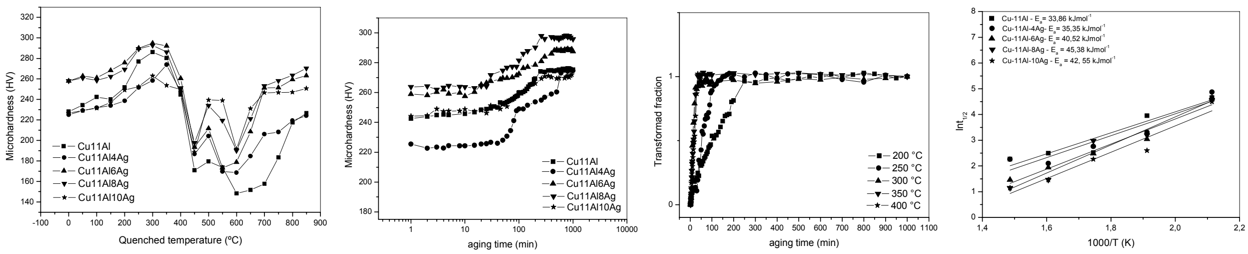
Abstract - The isothermal kinetics of the martensitic phase decomposition in the Cu-11wt.%Al alloy with Ag additions was studied using optical microscopy(OM), scanning electron microscopy (SEM), X-ray diffractometry (XRD) and microhardness measurement with temperature and time. The results indicated that, during the time and temperature range considered, the martensitic phase decomposition was not observed. The obtained activation energy values were associated with the martensitic phase ordering reaction assisted by migration of quenched-in vacancies.

Cu-Al alloys containing 9-14 wt.%Al are among those showing a martensitic phase after the rapid cooling from high temperatures. The martensite aging in these alloys leads to formation of the eutectoid (α+ γ_1) phase and the presence of an interposing order-disorder reaction, substitutional type parent and product phases, makes the eutectoid reaction in this system distinguishable from other ones. Silver additions to Cu-Al alloys increase its hardness, influence the nucleation rate and the activation energy of the eutectoid decomposition reaction [1]. In this work, the isothermal kinetics of the martensitic phase decomposition in the Cu-11wt.%Al alloy with Ag additions was studied using optical microscopy(OM), scanning electron microscopy (SEM), X-ray diffractometry (XRD) and microhardness measurement with temperature and time. The Cu–11wt.%Al alloy with additions of 0, 4, 6, 8 and 10wt.%Ag was prepared in an induction furnace under argon atmosphere. The samples were annealed during 120 h at 850 °C for homogenization and then equilibrated at 900 °C for one hour and quenched in iced water. Some quenched samples were aged at five different temperatures, chosen about the maximum of the isochronic curves (fig. 1-a) and the hardness measurements on the aged samples gave the hardness/aging time curves (fig. 1-b). The results indicated that, during the time and temperature range considered, the martensitic phase decomposition was not observed. A linear relationship between $t_{1/2}$ and 1/T was obtained from plots of transformed fraction vs. aging time curves (see figs. 1-c and 1-d) and the activation energy for the aging process was obtained from the slope of the straight lines in fig. 1-d. The obtained activation energy values vary between 34 and 42 $kJmol^{-1}$ and increase with the increase in the Ag content. From literature it is known that the activation energy for the migration of a vacancy in Au-Cd martensitic phases is at about 42.47$kJmol^{-1}$[2]. Considering that this is the energy for a jump of a vacancy, which is the rate determinant process for martensite aging, the activation energy values obtained for the Cu-11wt.%Al alloy with Ag additions may be associated with the martensitic phase ordering reaction assisted by migration of quenched-in vacancies. The increase in the activation energy with the increase in the Ag concentration may be associated with vacancies annihilation by Ag atoms.



(a) (b) (c) (c)

Figure 1: (a) Plots of microhardness vs. quenched temperature for the studied alloys. (b) Microhardness vs. aging time curves for alloys aged at 200°C. (c) Transformed fraction vs. aging time for the Cu-11wt.%Al alloy. (d) Plots of ln $t_{1/2}$ vs. 1000/T (K) for the studied alloys.

References

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[2] Y. Murakami, Y. Nakajima, K. Otsuka, T. Ohba, R. Matsuo, K. Oshima, Mater. Sci. Eng. A 237 (1) (1997) 87-101.