



## Martensite decomposition in the Cu-22.55at.%Al alloy with Ag additions

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**Abstract** - The martensite decomposition in the Cu-22.55at.%Al, Cu-22.63at.%Al-0.51at.%Ag, Cu-22.71at.%Al-1.03at.%Ag and Cu-22.79at.%Al-1.55at.%Ag alloys was studied using microhardness measurements, scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX) and X-ray diffractometry (XRD). The results indicated that the final product on aging is the  $\alpha$ -Cu rich phase instead of the ( $\alpha+\gamma_1$ ) complex phase. This change was associated with a mechanism similar to that proposed for the bainitic transformation.

Isothermal microhardness vs. aging time curves may be associated with system evolution and in a first order phase transition at different temperatures the system changes from a metastable state to a more stable one, corresponding to a relative minimum of the thermodynamic function. This transition is related to the surmounting of an energy barrier between these relative minima. Martensite aging in the Cu-12.4wt.%Al alloy with Ag additions leads to the ( $\alpha+\gamma_1$ ) phase formation and modifies the lamellae structure of this phase, with activation energies values associated with the ( $\alpha+\gamma_1$ ) phase formation around  $40 \text{ kJmol}^{-1}$  [1]. In Cu-Al-Ag alloys, the martensitic phase is formed from an ordered beta-one phase then martensite inherits the order and be already ordered as quenched. Silva et al [2] showed that in Cu-Al-Ag alloys, on aging, this martensite evolves to a martensite more ordered than that produced on quenched, before the decomposition. In this work, the martensite aging in the Cu-22.55at.%Al, Cu-22.63at.%Al-0.51at.%Ag, Cu-22.71at.%Al-1.03at.%Ag and Cu-22.79at.%Al-1.55at.%Ag alloys was studied using microhardness measurements, scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX) and X-ray diffractometry (XRD). Analyses of isothermal microhardness vs. ageing time curves and X-ray diffraction patterns indicated that the martensite ordering reaction is the dominant process during initial stages on the aging, followed by the  $\alpha$ -Cu rich phase precipitation reaction. Scanning electron micrographs and EDX spectra showed that, for longer ageing times (about  $10^4$  min), almost all martensitic phase is transformed into the  $\alpha$ -Cu rich phase with metallic Ag precipitated on it, probably by a mechanism similar to that proposed for the bainitic transformation. The  $\alpha$ -Cu rich phase seems to have an orientation relationship with martensitic phase produced on fast cooling, while the martensite decomposition reaction and the subsequent ( $\alpha+\gamma_1$ ) phase formation was not observed. This suggests that martensite aging follows a reaction mechanism different from that proposed for the Cu-12.4wt.%Al alloy with Ag additions [1]. The scanning electron micrographs showed that the presence of Ag changes the orientation relationship of the precipitated  $\alpha$ -Cu rich phase and for the Cu-22.79at.%Al-1.55at.%Ag alloy the relative fraction of the  $\alpha$ -Cu rich phase is decreased. Therefore, the final product on martensite aging in the Cu-22.55at.%Al alloy with Ag additions is the  $\alpha$ -Cu rich phase precipitated from the martensitic phase, in the time and temperature ranges here considered. These results seems to indicate that the decomposition of the martensitic phase in the Cu-Al alloy with Ag additions occurs in the presence of a large amount of the  $\alpha$ -Cu rich phase, produced from a bainitic-type transition. Some Cu-base alloys undergo a bainitic transformation on post-quench aging at intermediate temperatures. It is well established that the transformation process in the alloys is controlled by diffusion of atoms, although the bainite plates may be nucleated through a shear mechanism [3]. In this way, the long-range diffusion and surface relief, characteristics of this transition, may be responsible for the  $\alpha$  phase precipitation and to the dissolution of the pearlitic phase. The increase in the Ag content seems to decrease the  $\alpha$  phase relative fraction, probably due to the formation of very small Cu-rich Ag precipitates.

## References

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