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# Effect of Ag addition on the martensitic phase of the Cu–10 wt.% Al alloy

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**Abstract**

Thermal analysis and compression tests at room temperature have been carried out for Cu–10 wt.% Al and Cu–10 wt.% Al–10 wt.% Ag alloys samples. The results indicate that the decomposition reaction of the ($\beta_1$) parent phase is decreased suppressed and a martensite stabilization effect can be induced by Ag addition. The Cu–Al–Ag alloy shows some degree of shape memory capacity.


*Keywords:* Shape memory; Martensite; Compression tests; Thermal analysis

## 1. Introduction

Copper-based alloys are widely used in many fields because of their good combination with high thermal and electrical conductivity and high strength. In particular, Cu base alloys with high performance are required in the field of electronic materials, such as substrate and lead frame in the printed board, interconnection and so on, because the electronic packaging has a tendency to miniaturization [1]. Some Cu-based alloys can exhibit the martensitic phase on the fast cooling, which is connected with the shape memory effect (SME). This effect has been attracted considerable attention in various industrials fields such as orthodontic arch wire, brassieres for women, eyeglass frame, antennas for cellular phones and recently as material for medical devices such as guides for catheters, stents and so on [2]. Cu–Al alloys containing 9–14 wt.% Al are among those showing a martensitic phase after the rapid cooling from high temperatures. The martensite ageing in these Cu–Al alloys leads to formation of the eutectoid ($\alpha + \gamma_1$) 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 [3]. Silver additions to Cu–Al alloys increase its hardness, influence the nucleation rate and the activation energy of the eutectoid decomposition reaction [4]. In this work the thermal and mechanical behavior of Cu–10 wt.% Al and Cu–10 wt.% Al–10 wt.% Ag alloys were analyzed using differential scanning calorimetric (DSC), scanning electron microscopy (SEM), optical microscopy (OM), high temperature X-ray diffractometry (XRD) and compression tests.

## 2. Experimental procedure

Cu–10 wt.% Al and Cu–10 wt.% Al–10 wt.% Ag polycrystalline alloys were prepared in an induction furnace under argon atmosphere using 99.97% copper, 99.95% aluminum and 99.98% silver as starting materials. Results from chemical analysis indicated a final alloy composition very close to the nominal one, with Pb, Fe, and Mn as main impurities (concentration less than 100 ppm).

Flat square samples of about 1.0 mm thickness and 5.0 mm length were obtained for metallography and X-ray diffractometry. These samples were initially annealed for 120 h at 850 °C for homogenization and after annealing they were equilibrated for 1 h at 850 °C and quenched in iced water in order to obtain the martensitic phase. After the heat treatments the samples were mechanically polished and electropolished in a solution of trioxide of chromium in phosphoric acid, etched and examined in

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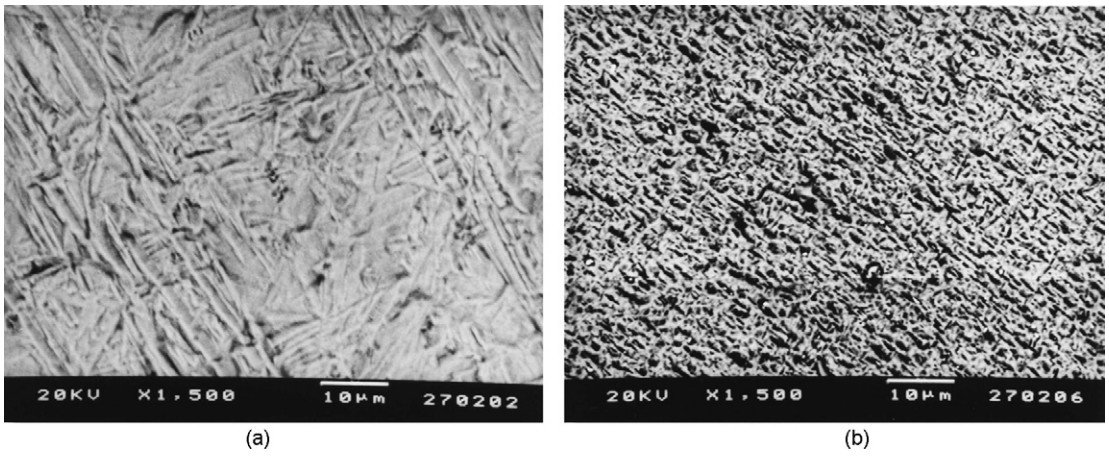


Fig. 1. Scanning electron micrographs obtained for the Cu–10 wt.% Al (a) and Cu–10 wt.% Al–10 wt.% Ag (b) alloys quenched from 850 °C.

an Riechter Mef optical microscope and in a Jeol JSM T330A scanning electron microscopy.

The in situ high temperature X-ray diffraction experiments were performed at the D10B-XPD X-ray diffraction beam line of the Brazilian Synchrotron Light Laboratory/MCT, with $\lambda = 1.746617$ Å and 7098.6 eV. Calorimetric data were obtained using a Rheometric Scientific DSC SP differential scanning calorimeter. The samples used were thin slices (1–1.5 mm thick and mass 20–100 mg), annealed at 950 °C for 30 min and followed by quenching into iced water. A Shimadzu Autograph-DSS-10T-S deformation universal machine was used for compression tests at room temperature and a constant cross-head speed of 0.5 mm min$^{-1}$. The stress–strain measurements were recorded and stored for further compu-

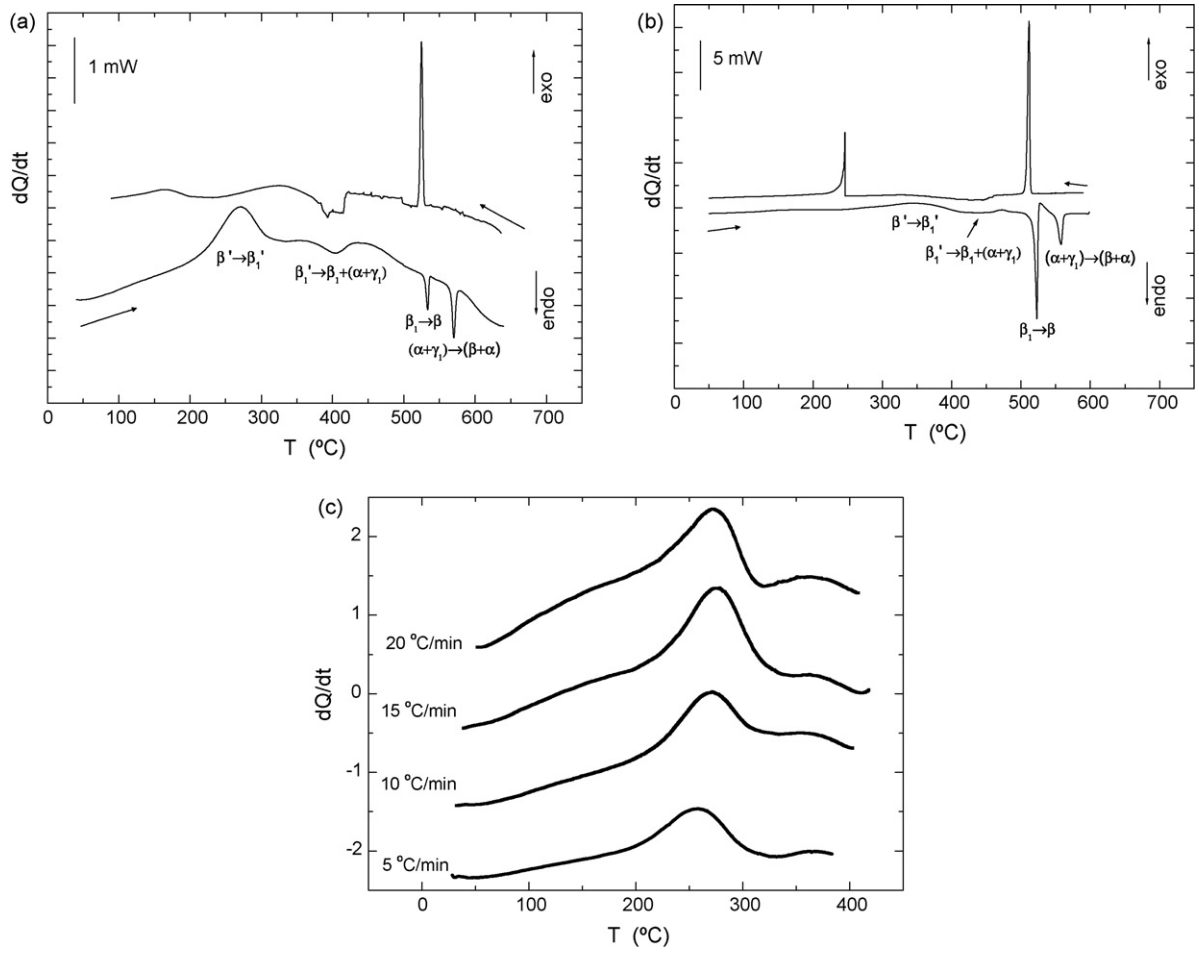


Fig. 2. DSC curves obtained for the Cu–10 wt.% Al alloy (a) and Cu–10 wt.% Al–10 wt.% Ag alloy (b) with heating and cooling rates of 10 °C min$^{-1}$; (c) DSC curves obtained for the Cu–10 wt.% Al alloy with different heating rates.