

EELS Study of the Electronic Structure Changes Associated with the Martensitic Transformation in a Cu-Al-Be Alloy

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Martensitic transformation has been observed in several materials and alloys. From these, Cu-based alloys have received considerable attention, because of their shape memory properties [1,2]. These alloys are characterized by a high temperature stable β -phase with cubic DO₃-structure. This phase can be retained at room temperature by quenching it to a metastable phase which transforms, after cooling, to the martensitic β' -phase with an orthorhombic 18R-type structure [3].

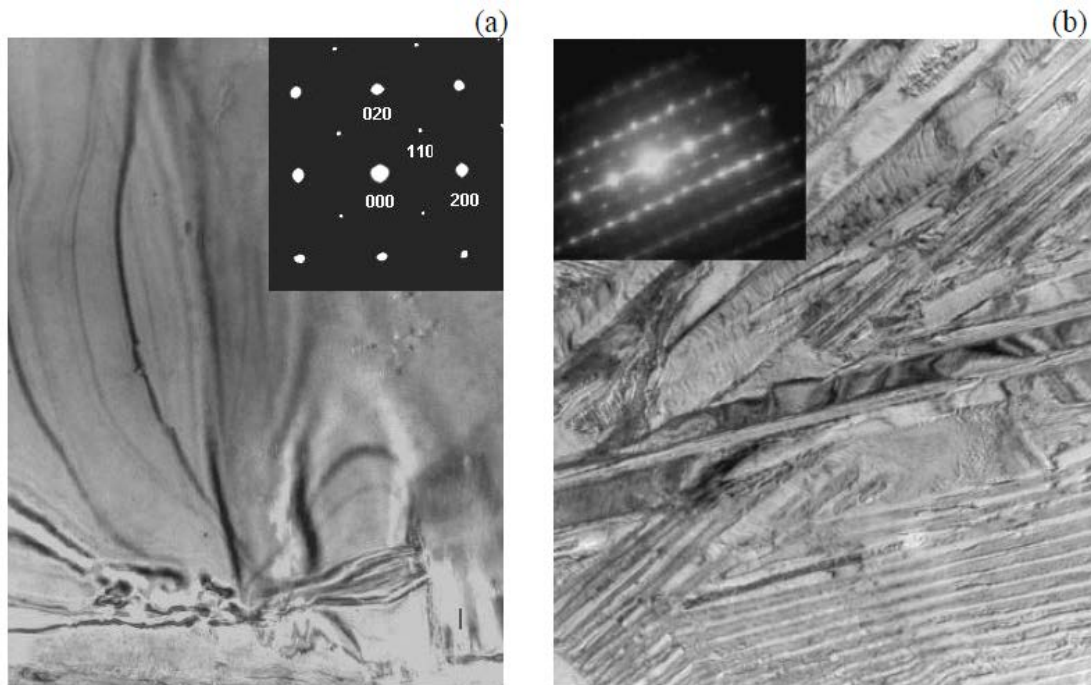
In this work, Electron Energy Loss Spectroscopy (EELS) in transmission mode was applied to a single crystal of Cu-11.24wt.%Al-0.5wt.%Be alloy, oriented in the [001] direction, in both low energy loss (<50 eV) and high energy loss (>50 eV) regions, in an in-situ heating-cooling cycle at 20, 200, 300, 500, 300, 200 and 20°C temperatures. Spectra were acquired with a Gatan PEELS (Model 766) attached to a Philips CM-200 TEM in diffraction mode.

Figures 1(a) and 1(b) show micrographs and diffraction patterns of the alloy at the beginning and the end of the thermal cycle, where it is clearly observed that a martensitic transformation has occurred.

The appearance of white lines at the threshold of Cu L_{2,3} ionization edges in the alloys are taken as evidence that some electrons have left 3d Cu states after alloying. Furthermore, the enhancement of these white lines during the transition from austenite to martensite are related to a further increase of unoccupied states during the phase transformation. Figures 2(a) and 2(b) show EELS spectra for

austenite and pure Cu and martensite and pure Cu, respectively. Following the work by Pearson et al. [4], it is concluded that about 0.1 electrons/atom have left Cu 3d states in austenite and 0.18 electrons/atom in martensite, that is, about 0.08 electrons/atom left Cu 3d states during the phase transformation from austenite to martensite, probably to hybridized states in the alloy.

From the low energy loss region the Optical Joint Density of States (OJDS) were calculated. Differences in spectra for austenite and martensite are used to infer changes in the electronic band structure.



FIGS. 1a. and 1b. Micrographs and diffraction patterns from Austenite and Martensite.

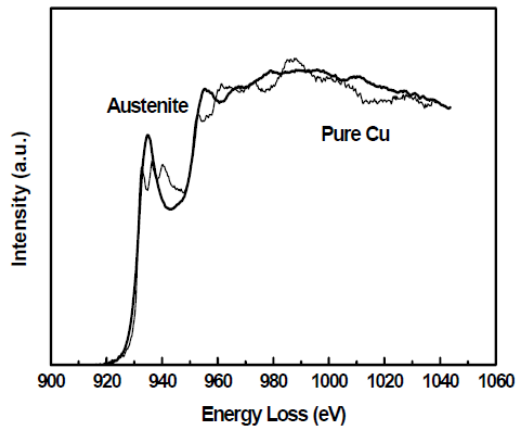


FIG. 2a. Cu $L_{2,3}$ ionization edges from Austenite and pure at room temperature

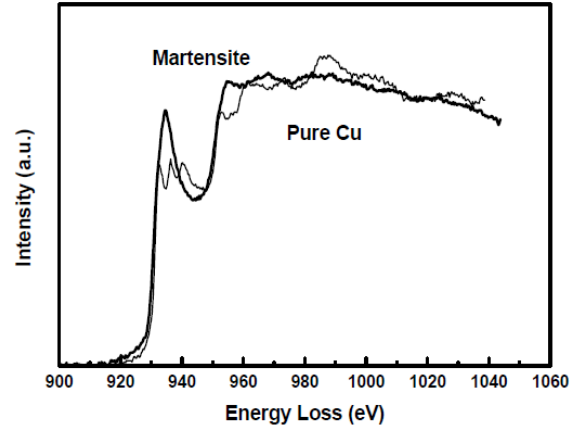


FIG. 2b. Cu $L_{2,3}$ ionization edges from Martensite at room temperature

References

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