Study of the evolution of two Al-Cu-(Li) alloys during thermal ageing

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In order to increase the operating temperature of the 2xxx aluminum alloys series for aeronautic applications, the microstructure evolutions due to a long thermal ageing have been investigated. A heat treatment, conducted at 200°C, was performed on an Al-Cu and an Al-Cu-Li alloys from 1000 hours to 10000 hours. Microstructure have been first characterized at different stage of ageing using conventional Transmission Electron Microscopes. The observations, in agreement with the literature, attest that the evolution of Al-Cu alloys is directly linked to the amount of copper in the matrix and the diffusion of copper between the various nano-precipitates present in the microstructure.

To understand the evolution of the local stoichiometry and how it influences the microstructure evolutions, STEM-EELS and STEM-EDX techniques were used to quantify this element in main microstructural features of the alloys. The STEM-EELS and STEM-EDX observations were respectively performed on a TECNAI F20 and a Philips CM20FEG, both microscopes being operated at 200 kV and equipped with a FEG source.

As the alloys are globally composed of a small amount of copper, about 4 wt.%, the accuracy of the quantifications performed by the two techniques have been questioned. To ensure robust results, measurements on binary alloy and on nano-precipitates which theoretical composition is known have been used as references. Indeed, nano-precipitates such as θ'-Al_2Cu or T_1-Al_2CuLi can be found in the studied alloys and the ratio between aluminum and copper content have been used to confirm the results of measurements made on the matrix.

Using this methodology, results have shown how the copper amount in the matrix evolves during the thermal ageing. As a result of this diffusion, the nano-precipitates are thickened during the ageing process and, due to the presence of other alloying elements, the shape and the crystallographic structure evolves. Even though, the copper amount in the matrix is decreasing, a stable microstructure has not been found.