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NANOINDENTATION CARTOGRAPHY IN Al/Al-Cu-Fe COMPOSITES: CORRELATION BETWEEN CHEMICAL HETEROGENEITIES AND MECHANICAL PROPERTIES

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During the last two decades, nanoindentation testing has become a commonly used technique for measuring surface mechanical properties such as hardness or elastic modulus. With devices equipped with a motorized X-Y table, it is now possible to perform large regular nanoindentation arrays in order to make an accurate statistics of the mechanical properties. This method is particularly interesting to study heterogeneous materials. The statistical analysis, associated to mathematical deconvolution methods allows identifying the properties of each individual phase. Furthermore, hardness or elastic modulus maps can be then established and compared to other local properties such as microstructure, crystallographic orientation or chemical composition. The nanoindentation cartography method has been used to study the mechanical properties of a metal matrix composite (Aluminum matrix with ω-Al-Cu-Fe reinforcement particles, synthesized by sparking plasma sintering) (cf. figure 1). Emphasize has been placed on the Aluminum matrix properties, where the detailed analysis of the individual nanoindentation curves shows serrated behavior characteristic of Portevin-Le Chatelier effect associated to dislocation pinning by solute atoms. The comparison between chemical (SEM – EDXS analysis) and hardness maps as well as the quantitative analysis of the deformation curves gives evidence of a strong correlation between the chemical heterogeneities and mechanical properties of the Aluminum matrix.

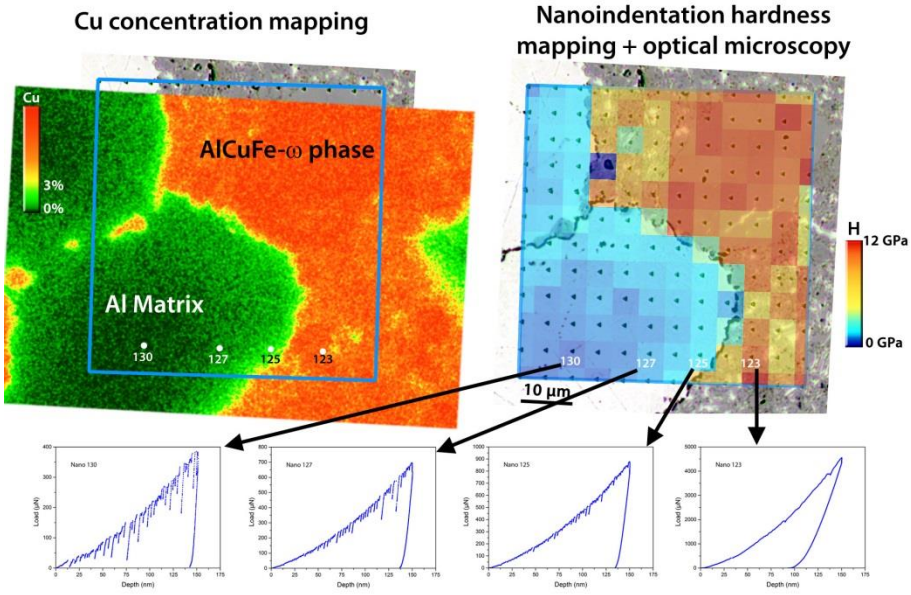

Figure 1 –Left side: SEM – EDXS analysis of the Cu concentration in the Al/AlCuFe composite. Right side: Nanoindentaion hardness mapping in the same region. Below: Nanoindentation curves showing a serrated behavior in the Al matrix.