Microstructural and mechanical characterizations of Mg-based nanocomposites with MAX phases or MXenes after severe plastic deformation treatments

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Greenhouse gas reductions and fuel efficiency have led to increased interest in the development of lightweight alloys. Composites are often good candidates, especially Mg composites with complex phases. $M_{n+1}AX_n$ phases (M: transition metal; A: A-group element; X: C or N and n, integer = 1,2 or 3) have remarkable properties such as low density, high modulus, good metallic conductivity, self-lubrication properties and unique mechanical behaviors both at room and high temperatures [1]. MAX phases are also the precursors for synthesizing one of the last largest 2D materials reported to date: MXenes. Such as graphene, these materials consist of few-atoms-thick layers, but are made of transition metal carbides, nitrides or carbonitrides [2].

Here we report detailed microstructural and mechanical characterizations of Mg-based nanocomposites with MAX phases or MXenes after severe plastic deformation (SPD) treatments by high pressure torsion (HPT) and surface mechanical attrition treatment (SMAT). Results obtained by microhardness, scanning electron microscopy, transmission electron microscopy and x-ray tomography are discussed in the framework of the relationship between the microstructure and the mechanical response of Mg-composites with such complex phases.

Keywords: magnesium; severe plastic deformation; MAX phase; MXene; nanocomposite

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References:

[1] J. GUÉNOLÉ, V. TAUPIN, M. VALLET, Y. WENBO, A. GUITTON, *Scripta Materialia*, 2022, vol. 210, p. 114425.
[2] M. BENCHAKAR, L. LOUPIAS, C. GARNERO, *T. BILYK, C. MORAIS, C. CANAFF, N. GUIGNARD, S. MORISSET, H. PAZNIAK, S. HURAND, P. CHARTIER, J. PACAUD, V. MAUCHAMP, M. W. BARSOUM, A. HABRIOUX, S. CÉLÉRIER, Applied Surface Science*, 2020, vol. 530, p. 147209.