Heydi Fernandez et al., J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C8-113

Microstructure evolution of A356 aluminum alloy reinforced with Si_3N_4 particles during mechanical milling

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Nano-composite A356-Si_3N_4 alloys were obtained by co-milling aluminium alloy A356 with different mass fractions (10, 20 and 30%) of Si_3N_4 in a planetary mill. The structural and microstructural modifications at different stages of the mechanical milling were investigated using Scherrer formula and Whole Powder Pattern Modeling (WPPM) of the X-ray powder diffraction (XRPD) pattern. Due to the inhomogeneity of the microstructure of the starting powder and of the milling process, the WPPM of XRPD data required the hypothesis of a multimodal distribution and the coexistence of multiple Al alloy fractions with different Si content. By increasing the milling time and the amount of reinforcing particles, the inhomogeneity decreases and a single lognormal distribution is enough to model the data. The dependence of lattice parameters on the coherent domain (crystallite) size during milling has been investigated. The lattice parameters were calculated in view of the non-equilibrium grain boundary structure that evolved during milling using excess free volume and the interfacial stresses at the grain boundaries.

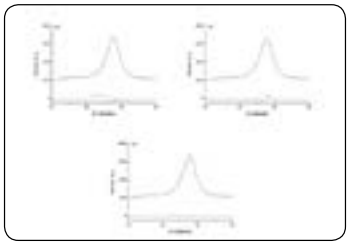

Figure 1: Experimental pattern of A356-10%Si3N4 composite at 3h of milling (black line), WPPM result (red line) and residual (blue line) of 200 reflection. The analysis using a lognormal distribution (a), using a free form size distribution (b) and using a bimodal lognormal distribution (c).

Recent Publications:

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2. P. Scardi, M. Leoni, Whole powder pattern modelling, Acta Crystallogr. Sect. A Found. Crystallogr. 58 (2002) 190–200. doi:10.1107/S0108767301021298.
3. S. Ordóñez, O. Bustos, R. Colás, Thermal and microstructural analysis of an a356 aluminium alloy solidified under the effect of magnetic stirring, Int. J. Met. 3 (2009) 37–41.
4. J. Chevrier, D. Pavuna, F. Cyrot-Lackmann, Electronic properties and superconductivity of rapidly quenched Al-Si alloys, Phys. Rev. B. 36 (1987) 9115–9121. doi:10.1103/PhysRevB.36.9115.
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Biography

Heydi Fernandez has her expertise in physico-chemical and structural characterization of materials. She is a regular student of the Science and Engineering Materials PhD program at University of Santiago de Chile (USACH), granted with the National Doctorate Scholarship CONICYT. She is developing her thesis in the area of powder metallurgy, specifically studying the microstructural and mechanical evolution of composites of aluminum alloy A356 reinforced with Si3N4. Her has worked with Nanomaterials as sorbent of divalent metal ions and dyes, also in the use of X-ray diffraction techniques and specifically in the microstructural refinement and texture analysis with the PM2K code for WPPM.

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