2788
doi:10.1017/S1431927622010522
Microsc. Microanal. 28 (Suppl 1), 2022

Development of an Aluminum Hybrid Metal Matrix Composite Processed Through Mechanical Milling (MM), with High Response to Yield Strength

Isaí A. Sánchez-Molinar[1], Daniel Lardizabal-Gutierrez[1], C. López-Meléndez[2], Jose M. Herrera-Ramirez[1] and C. Carreño-Gallardo[1*]

[1.]Centro de Investigación en Materiales Avanzados (CIMAV). Laboratorio Nacional de Nanotecnología. Miguel de Cervantes No. 120, 31136, Chihuahua, Chih., México.
[2.] Universidad La Salle Chihuahua, Prol. Lomas de Majalca No. 11201, C.P. 31020 Chihuahua, México.
* Corresponding author: caleb.carreno@cimav.edu.mx

Metal matrix composites are considered as engineering materials due to their possible redesign and improvement of its physical and chemical properties [1], and so, satisfice industry requirements. Aluminum metal matrix composites are the most used due they have good wear resistance, high hardness, low density, better rigidity and, in general, they have a low cost compared to other materials. Normally the material used as reinforcement is a ceramic-like silicon carbide (SiC), boron carbide (B_4C). However, the yield strength tends to decrease due to the significant difference between matrix(low) and reinforcement (high) yield strength. The objective of this work is to decrease the difference with a metallized reinforcement that consists in covering silicon carbide (SiC) with nickel (Ni), which has a yield strength similar to aluminum that results from a composite with good mechanical behavior.

It has been reported that silicon carbide (SiC) has a young's modulus of 410 GPa and aluminum has 68 GPa [2]. An addition of 60wt% SiC into 6061-Al increased yield strength reaches up to 200%, however, the material becomes very brittle [3]. Another study determined that addiction 0.5-1.5% nano SiC in pure aluminum increases the yield strength to 31-58%, nevertheless, when the composition nano SiC is up to 2% the yield strength is 38%, a decrease in comparison to 1.5% [4].

We applied thermolysis to synthesize the reinforcement nickel-silicon carbide (95-5wt%) with < 100 nanometer particle and powder metallurgy to develop aluminum hybrid metal matrix composite, in order to improve the mechanical properties. In our research, reinforcement Ni-SiC was added between 0.5 and 5wt% into pure aluminum. Yield strength, ultimate strength and hardness increased significantly by the addition of Ni-SiC. An analysis of TEM-EDS was done to observe SiC particles metallized with Ni. Likewise, an analysis SEM was performed to find the interaction between Ni-SiC and the aluminum metal matrix.

Figure 1, shows a comparison of the addition of 5wt% Ni-SiC and pure aluminum, and we can observe an important improvement in the yield strength from 200 to 382 MPa.

In figure 2 (a) we can see the interaction Ni-SiC. SiC is distributed in the Ni particles and we can use it as a reinforcement to develop metal matrix composite. In figure 2 (b) we observed that the reinforcement is very well dispersed in the aluminum metal matrix with <2 micrometers particles. The reinforcement particles composition is Al_3Ni with SiC interaction according to the Al-Ni phase diagram.

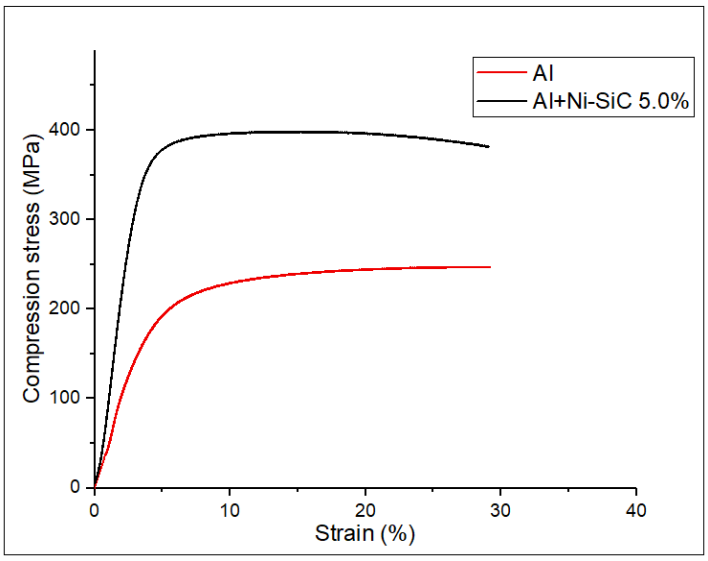

Figure 1. Compression stress-strain curves of aluminum pure and 5wt% Ni-SiC

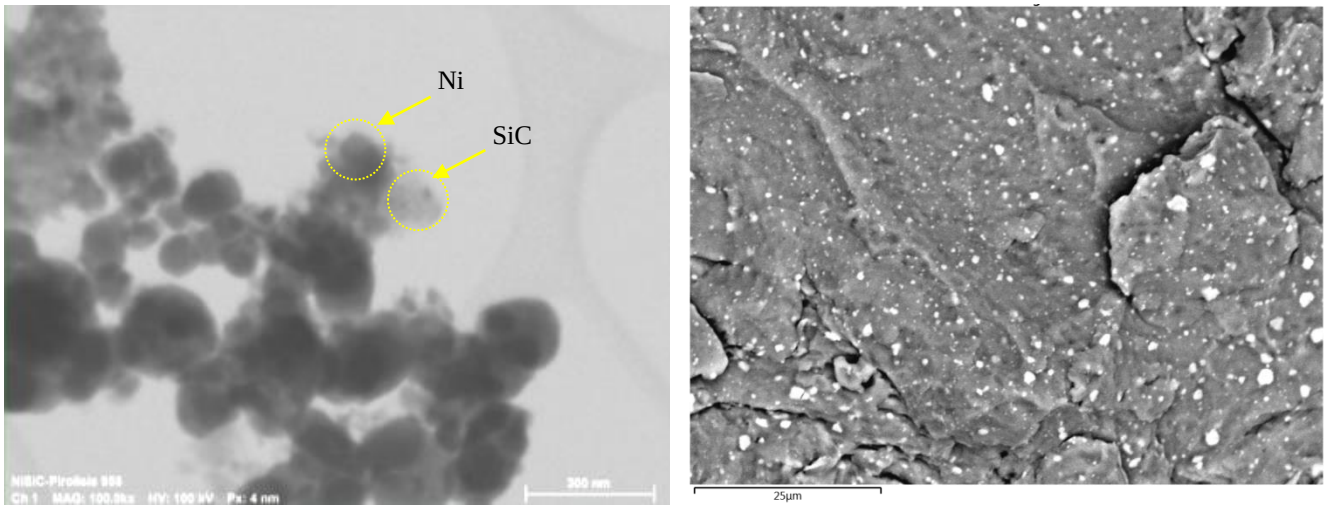

Figure 2. a) Analysis TEM of the reinforcement Ni-SiC. b) aluminum hybrid metal matrix composite with the reinforcement dispersed.

https://doi.org/10.1017/S1431927622010522 Published online by Cambridge University Press

References:

[1] Shakil H, M. M, Elservier (2019), p. 1458-1461. doi: 10.1016/j.matpr.2019.10.089
[2] Matweb: Online Materials information Resource, http://www.matweb.com (accessed 2/15/2022).
[3] Khadijeh M, Ali Alizadeh (2021), p 2406-2413. doi: 10.1016/j.ceramint.2020.09.083
[4] P. Pragathi, R. Elansezhian (2022), 103204. doi: 10.1016/j.mtcomm.2022.103204

https://doi.org/10.1017/S1431927622010522 Published online by Cambridge University Press