2254
doi:10.1017/S1431927618011753

Microsc. Microanal. 24 (Suppl 1), 2018

An Al-Li Powder Alloy Prepared by Mechanical Milling and Sintered Using High Frequency Induction

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The aluminum-lithium alloys are very attractive materials for structural applications due to their high strength and low density [1]. Some authors mentioned that to improve the ductility of these alloys, the Al-Li powders could be processed through a solid-state route using mechanical alloying (MA) [2]. Normally, for these types of alloys, a low concentration of Li is maintained to ensure their stability to air [3].

This work involves the preparation and microstructural characterization of an Al-Li alloy by high-energy ball milling. In order to obtain solid samples, the prepared powders were sintered. An AlLi-2% (in wt.%) alloy was prepared from a weighted mixture of pure Al and AlLi-5% chips and processed in a SPEX 8000M mill by 2 hours. Then, the prepared powders were sintered following two different methods: in the conventional method (CM) the samples were cold compacted (900 MPa) and subsequently sintered (550°C) during 3 hours in a furnace. Meanwhile, using an alternative route based on high frequency induction (HFIS), the samples were compacted (450 MPa) and heated (450°C) simultaneously for only 3 minutes.

The Fig. 1 presents images showing the final appearance of the sintered samples by the CM and HFIS techniques. Is important to mention that the AlLi-2% powders were difficult to sinter by CM due to their high-reactivity with air (occluded in the specimen) at elevated temperature during the pressure-less sintering stage; this results in cracked and deformed samples (Fig. 1A). In contrast, by HFIS the samples do not present these visible defects (Fig. 1B). Based on the TEM micrographs shown in the Fig. 2, it is evident the effectiveness of the HFIS technique on the retention of the typical laminar microstructure achieved by MA processing. In order to confirm the presence of Li in the sample and due to Li is not detectable by EDS, a zone of the sample was analyzed and its selected area diffraction pattern was obtained (Fig. 3). By measuring the SAD pattern, a value (4.0471 Å) near of lattice parameter of the AlLi intermetallic was obtained, confirming the existence of the phase.

Based on the above results, we can conclude that the HFIS constitutes an efficient method to sinter AlLi powders retaining the refined microstructure achieved by MA, keeping the dimensional integrity of the samples.

References:

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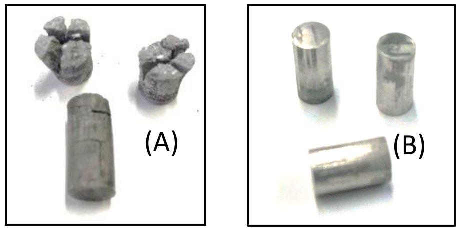

Figure 1. General view of the samples sintered by CM (A) and HFIS (B).

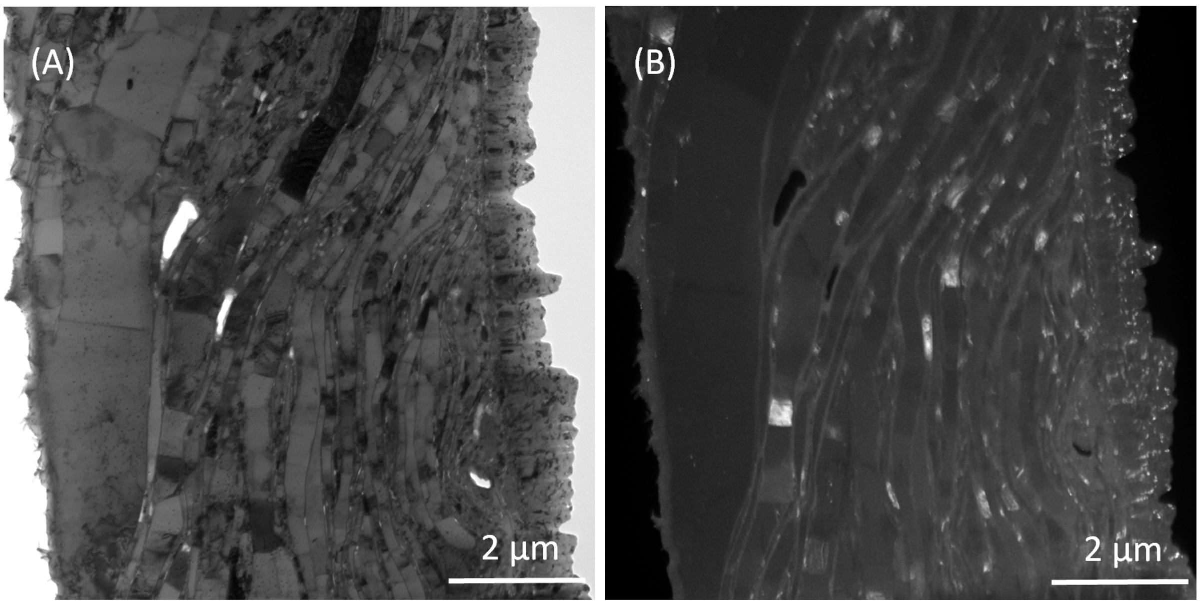

Figure 2. TEM-BF (A) and TEM-DF (B) micrographs of the AlLi-2% sample milled and HFIS sintered. The specimen was prepared by focused ion beam.

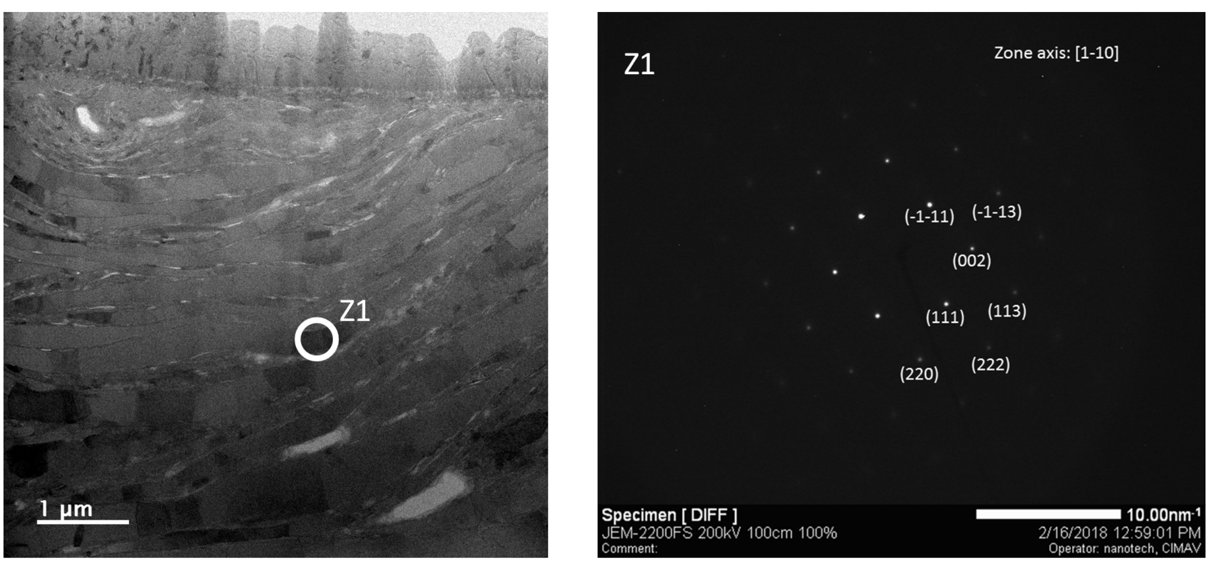

Figure 3. STEM micrograph and SAD pattern of the AlLi-2% sample prepared by HFIS.