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Influence of Salt Fluxes on Recycled Al Nanocomposites Reinforced with TiO2 Nanoparticles Produced in Liquid State

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Aluminum reinforced with hard nanoparticles are very attractive in many applications in the industry, this kind of materials form part of the group of materials named Metal Matrix Nanocomposites (MMNCs). An important characteristic of these kinds of materials is the low contents of reinforcement material required to improve significantly the mechanical properties of the Al matrix. In the present work, nanocomposites based recycled aluminum alloy 6063 swarf with hard nanoparticles of TiO2 were fabricated by combining techniques such as mechanical milling, stir-casting method and the use of different types of salt fluxes additions. Microhardness tests were carried out in order to identify the effect of flux additions on the reinforcement dispersion into the Al matrix. The microstructure of the nanocomposites were characterized by optical microscopy (OM), scanning electron microscopy (SEM), and energy dispersive X-ray spectroscopy (EDS).

The efficiency in recovering Al alloy 6063 swarf using different combinations of salt fluxes is depicted in the Fig. 1a. The best efficiency measure results are for the samples with low salt fluxes concentration, this results also show a relative small standard deviation. On the other hand, samples with high salt fluxes content shown to be less efficient in recovering Al, the relative large standard deviation data means major difficulty to keep under control the casting. The graph of Fig. 2b shows the microhardness results of both solubilizing at 550 ° C for 1h and aging at 220 °C for 10 h of samples processed without salt flux and with low, mid and high salt flux contents. In general for all samples, the microhardness increased significantly with the artificial-aging. The samples with high salt flux content showed the best mechanical properties but with a greater dispersion of data. Again, an increase of salt flux content results in a fast increase in temperature of the stir casting process resulting in a great variation of the reinforcement dispersion results.
The SEM backscattering image (see Fig. 2a and b) shows the microstructure of the Al-6063/TiO2 nanocomposite aged at 220 °C during 10 h. The images show the morphology and dispersion particles into the recycled Al matrix, some of these particles are in the range of the micrometers (Fig.2a) and other in the range of the nanometers (Fig.2b). Most of these particles correspond to intermetallics (e.g., Al-Fe-Si-Mn, Mg-Si, Al-Cu-Mg-Si) formed during the aging treatment. It is important to note the presence of a nanostructured condition (see Fig. 2b) as a result of the presence of TiO_2 nanoparticles dispersed (not found with this technique because the low content of TiO2) into the Al matrix during the stir casting process.

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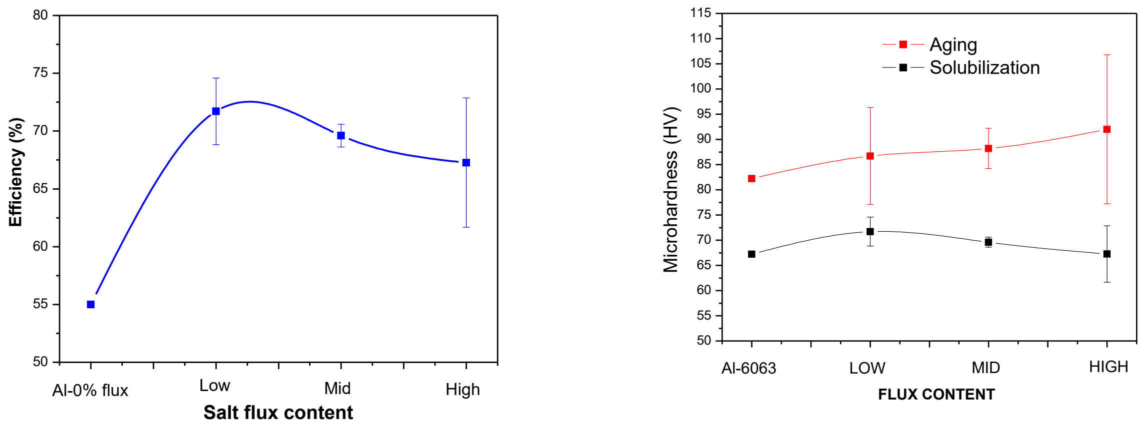

a) b)

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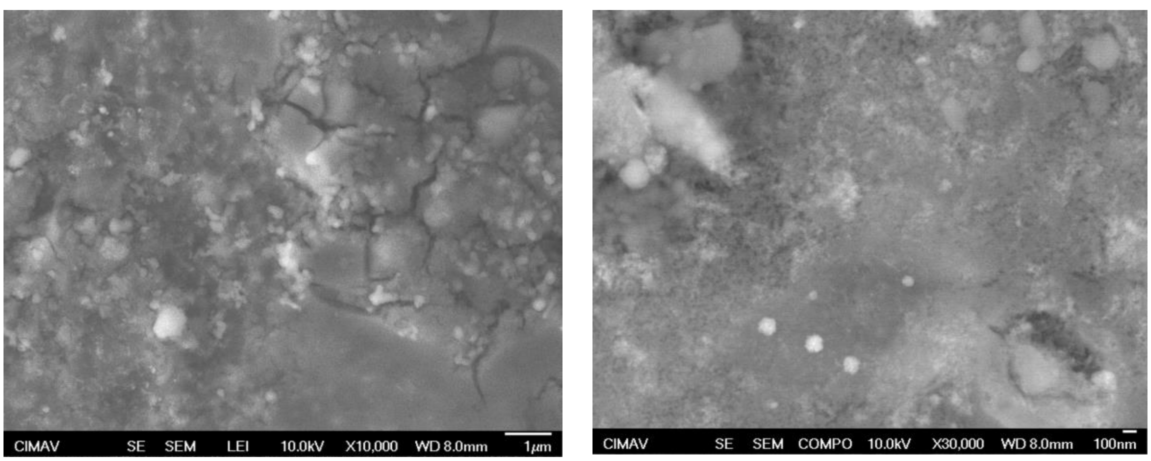
Figure 1. a) Percent of efficiency in recovering Al alloy 6063 swarf as a function of flux content, b) Microhardness results as a function of salt fluxes content of all samples



a) b)

Figure 2. a) SEM backscattering image of the Al-6063/TiO2 nanocomposite microstructure aged at 220 °C during 10 h. b) nanostructured condition and morphology and dispersion of nanoparticles of the sample.

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