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doi:10.1017/S1431927618011972
Microsc. Microanal. 24 (Suppl 1), 2018

Microstructural Study of a Zn-Ni Alloy Prepared by Ball Milling Using Two Different Devices

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Metallic zinc (Zn) has ben extensively used as protective coating of iron and steel for decades, but problems related with its high permeability has reduced its application. It was found that the corrosion resistance of zinc in form of alloys is increased by adding some transition metals. Recently, the Zn-Ni system is under research as an efficient alternative as anticorrosion coating for metals. Zn-Ni is mostly prepared by electroplating or thermal spray technologies, but there are some problems like: (i) fluctuation of Zn-Ni contents, (ii) the pollution caused by plating solutions and (iii) irregular thickness of the coating [1]. The mechanical alloying (MA) technique can be used to fulfill the above issues because this route facilitates the synthesis of homogeneous materials from powder mixtures [2]. Also, MA is frequently employed for the preparation of new materials based on mechanochemical reactions performed at room temperature, while avoiding the conventional ingot metallurgy [3]. This work deals with the preparation and study of a Zn-Ni alloy prepared by MA using two types of milling devices: a planetary which works manly through abrasion and impact of grinding balls and the Spex which works through the high-energy impact of balls. Zn-Ni was prepared from pure Ni and Zn powders, the equiatomic compositions were weighed and milled for 4 hours followed by sintering at 357°C during 1h.

By SEM analyses we can notice that the planetary sample presents semispherical coarse particles composed by unreacted Ni on the Zn matrix as well as the presence of oxygen (Fig. 1a). In contrast, the Spex sample consists of a tiny collection of Ni particles uniformly distributed into the Zn matrix; meanwhile the presence of oxygen is scarce (Fig 1b). The EDS analyses confirm the above results. The Fig. 2 shows the X-ray diffraction of both samples after the sintering process. The planetary sample is composed mainly of unreacted Ni, an intermetallic Zn_3Ni and oxides (ZnO and NiO) derived from the sintering process. On the other hand, Spex sample mainly consists of nanometric Ni particles mixed in the intermetallic phase.

Based on SEM and DRX analyses, it is observed that: the samples milled in the Spex device showed the formation of Zn_3Ni intermetallic phase, they present a smaller particle size, absence of oxygen contamination and a homogenous distribution of components compared to the planetary-processed samples. This could be related to their different milling energies and involved grinding mechanisms.

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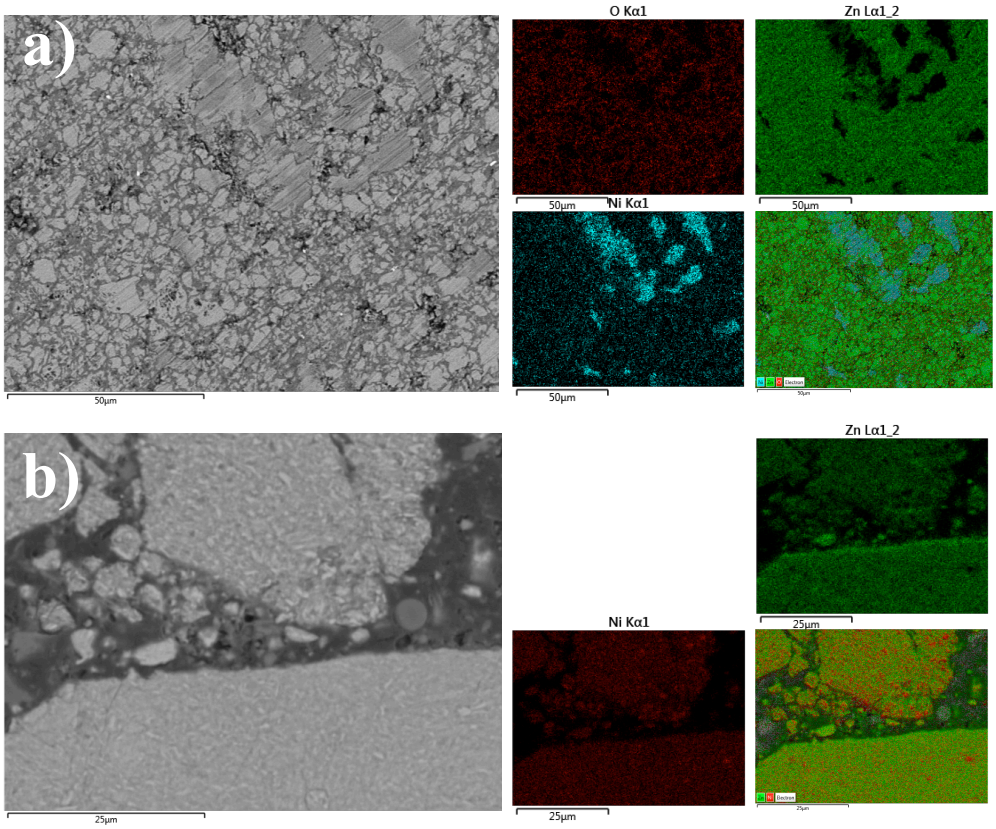

Figure 1. SEM-BSE micrographs of milled and sintered samples processed by (a) planetary and (b) Spex mills with their respective EDS mapping analyses

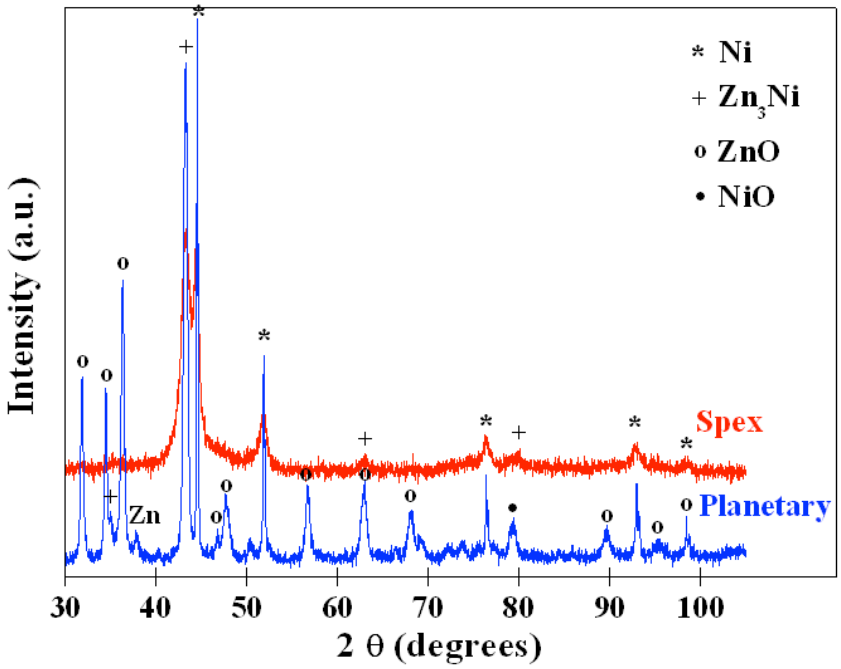

Figure 2. XRD comparative graph of the milled and sintered samples, showing the found phases.

https://doi.org/10.1017/S1431927618011972 Published online by Cambridge University Press