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MORPHOLOGY OF MONEL POWDER PROCESSED BY HIGH ENERGY MILL

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The term "mechanical alloying" is used to describe a solid-state alloying method where elemental powders are processed in high energy mills [1]. By this technique, high energy is transferred to the powder allowing the synthesis of an alloy with high chemical homogeneity through repetitive cycles of welding and fracture [2].

A flaky shape is usually obtained when elemental powders are processed in a attritor mill. This flaky powder alloy is usually ductile. This situation provides after compacting, a low green strength. In this paper the effect of the addition of polyethylene wax on size and shape of monel powder (50 % wt Ni-50 % wt Cu) was evaluated.

It was used an attritor mill of 0.25 litter capacity to process the copper and nickel powder mixture. All processing was performed in nitrogen atmosphere using chromium steel balls 7 mm diameter and a ball/powder ratio of 10:1. The impeller rotation was 1400 rpm and processing times of 5 and 15 hours and the polyethylene wax used was the Shamrock C640X83, in the amount of 1 % in weight.

Figure 1 shows the X-ray diffraction patterns of the elemental powder mixture and the powders 5 hours processed with and without addition of wax. It can be seen in pattern III, that is possible to achieve the alloying after 5 hours. Moreover, the pattern II shows that the addition of the wax had a negative effect, delaying the alloy formation.

The SEM micrographs of the processed powders are presented in figure 2. The flaky particle shape was observed after 5 hours processing without and with polyethylene wax, as presented in figures 2a and 2b, respectively. It could be verified that the addition of the wax at the beginning of the process had no effect on size and shape of powder until 5 hours. Figure 2c shows the monel powder processed for 15 hours, it observed no significant effect on particle size and shape related to the powder processed for 5 hours. This fact indicates that the welding and fracture occurred at almost the same rate.

In order to verify the influence of initial shape of monel powder, it was added wax to the flaky powder. Figure 2d shows the powder processed during 15 hours with additional 2 hours of processing in the same condition. It was observed smaller particle size and more spherical shape than the starting powder, figure 2c. This result indicates that the wax has a strong effect on powder shape when the starting powder has a flaky shape. It appears that the wax has an influence on the dynamic equilibrium of welding and fracture mechanisms, decreasing the welding rate.

References

1. A. Calka, *Key Engineering Materials*, 81-83 (1993) 17.

2. F. Cardelline, G. Mazzone, M. Vittori Antisari, *Acta Metall. Mater.*, 44 (1996) 1511.

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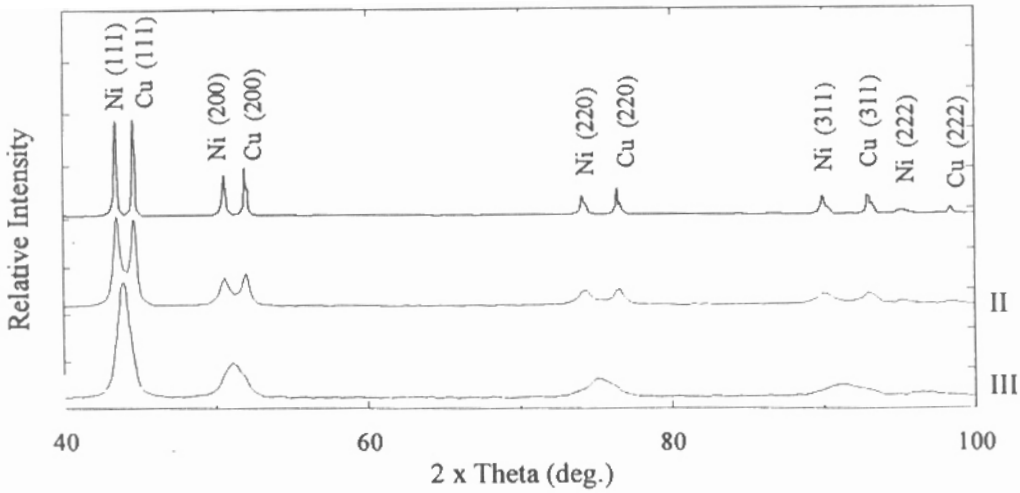
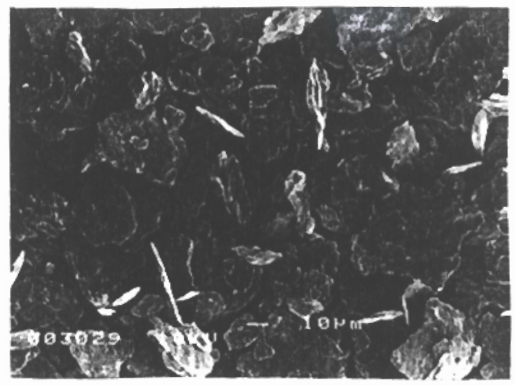


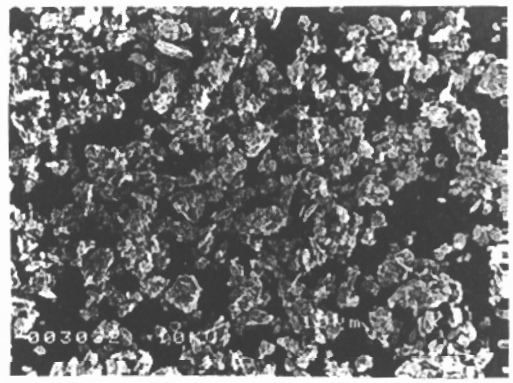
Figure 1 - X-rays diffraction patterns of the elemental powder mixture (I), powder 5 hours processed with wax (II) and powder 5 hours processed without wax (III).

(a)



(b)

(c)



(d)

Figure 2 - SEM micrographs of the powder processed. (a) 5 hours. (b) 5 hours with wax. (c) 15 hours. (d) Powder 15 hours processed without wax plus 2 additional hours with wax.