LASER ALLOYING OF Al WITH MIXED Ti AND Ni POWDERS TO IMPROVE SURFACE PROPERTIES

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Aluminium is used in industry for various applications due to its low cost, light weight and excellent workability, but lacks wear resistance and hardness. Laser alloying is used to improve surface properties such as hardness and wear resistance by modifying the composition and microstructure of the surface without affecting the bulk properties of the material[1].

In this investigation the surface of aluminium AA 1200 was laser alloyed using a 4.4 kW Rofin Sinar Nd:YAG laser to improve its hardness and wear resistance. The alloying was performed with different Ni and Ti powder weight ratios at different scanning speeds (0.010, 0.012, 0.015 and 0.020 m/s). The laser spot size was 3 mm. The shielding gas used was argon at a flow rate of 2 L/min. The intermetallics formed were examined using optical and scanning electron microscopy. The phases were identified by XRD and EDS analytical techniques. The abrasive wear tests were performed in accordance with the ASTM B611-85 standard. The abrasive used was silica sand with the sieve grading of 45 AFS. Test specimens were 20 mm x 20 mm x 5 mm in size and the load was 10 kg force.

A homogeneous alloyed layer was obtained at 0.010 m/s and 0.012 m/s laser scanning speed. Analysis was not performed for higher scan speeds since undissolved powders formed. The thickness and penetration depth of the alloyed layer were approximately 0.045 and 0.471 mm respectively. Fig. 1 shows hardness as function of Ti wt% in the alloyed layer for the 0.010 and 0.012 m/s laser scan speed. The optimum hardness was achieved for 20 wt% Ti and 80 wt% Ni powders at 0.010 m/s scan speed. A decrease in hardness was observed as the Ti weight content was increased. A cross section SEM micrograph of the laser alloyed specimen is shown in Fig. 2. The micrograph was taken on a polished specimen and shows an aluminium base (A) and a dendritic microstructure formed in the alloyed layer (B). XRD pattern of the phases formed is shown in Fig. 3. The phases present were identified as Al, Al_3Ni, Al_3Ti, NiTi and Al_3Ni_2.

The wear resistance increased as the Ti content decreased, which correlated with the hardness values obtained. This was expected since it is well documented that increasing the hardness increases the wear resistance of an alloy in conventional techniques[2].

Alloying Al with Ti and Ni powders improved the hardness and wear resistance with optimum values obtained for 20 wt% Ti and 80 wt% Ni.

References

1. Man, H.C., Zhang S., Cheng, F.T. (2007), Materials Letters, 61, 4058-4061.
2. Hutchings, I. M. (1992), Tribology: Friction and Wear of Engineering Materials, USA, Edward Arnold.

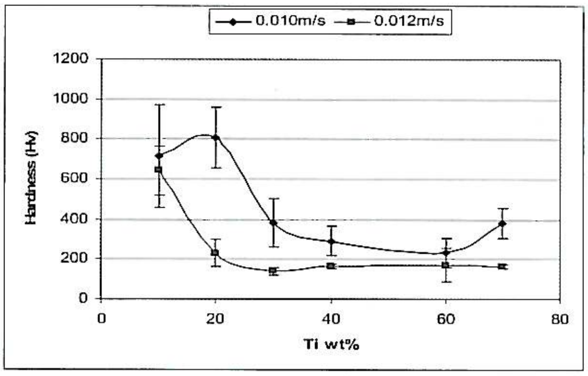

Figure 1: Graph of hardness versus Ti weight percentage.

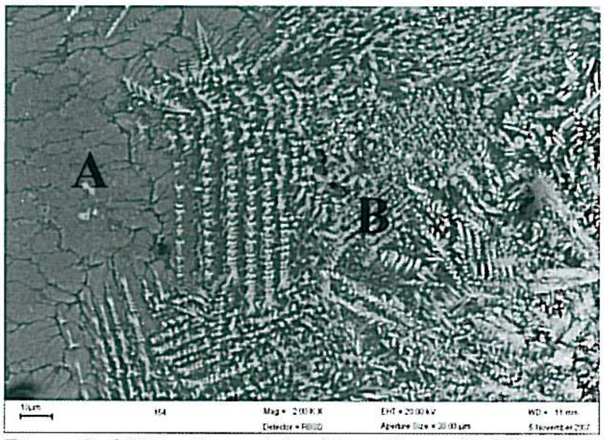

Figure 2: SEM micrograph of the alloy with 20 wt% Ti and 80 wt% Ni showing Al base (A) and the alloyed layer (B).

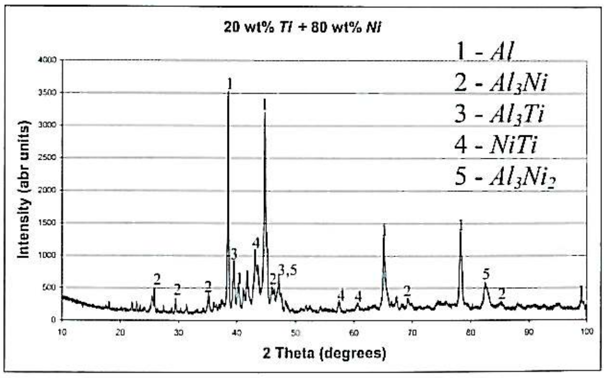

Figure 3: XRD pattern of the phases present.

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