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Studying the microstructure, physical & mechanical properties of Al matrix reinforced with bi-modal particles coated with either Ni or Cu

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KEYWORDS

Nanocomposites; Nanocoating; Microstructure. Wear, Powder metallurgy

SHORT SUMMARY

In the current study, a new generation of aluminum hybrid composite was successfully fabricated using powder metallurgy technique. The Al matrix was reinforced with Ni or Cu coated (SiC-Y2O3) particles with 2.5, 5, and 7.5 wt% content and a 50:50 ratio of SiC to yttria. For the purpose of studying the effect of the different weight percentages of the reinforcement material on the properties of the composite, a series of tests were performed. The samples were examined by optical, SEM, and TEM microscopy. XRD was also used for phase identification. Wettability test also showed similar results as the Ni coated samples exhibited a hydrophilic nature while the Cu coated ones had a more hydrophobic nature. For examining the mechanical and tribological properties of the composites, a microhardness test was conducted. A pin-on-disc test was also conducted to study the wear rate of the samples. It was found that increasing the wt% of reinforcement decreases the wear rate of the Al composite with the best values at 0.5 m/s sliding speed and 7.5 wt% of reinforcement.

EXTENDED ABSTRACT

The physical, tribological, mechanical, and thermal properties of aluminum matrix hybrid composites vary depending on the type, volume fraction, size, and distribution of reinforcements [1, 2, 3]. In the current study, a new generation of aluminum hybrid composite was successfully fabricated using powder metallurgy technique. The Al matrix was reinforced with Ni or Cu coated ($SiC-Y_2O_3$) particles with 2.5, 5, and 7.5 wt% content and a 50:50 ratio of SiC to yttria. For the purpose of studying the effect of the different weight percentages of the reinforcement material on the properties of the composite, a series of tests were performed. The samples were examined by optical, SEM as shown in Figures 1 and 2, and TEM microscopy which showed uniform distribution of the reinforcement material and a uniform and complete coating in the Cu coated samples. XRD was also used for phase identification and a $AlNi_5Si_2$ peak was observed in the Ni coated samples indicating an interaction between SiC particles and the Al matrix. Another AlCu6 peak was observed in the Cu coated samples confirming complete coating in Cu coated samples. Wettability test also showed similar results as the Ni coated samples exhibited a hydrophilic nature while the Cu coated ones had a more hydrophobic nature. For examining the mechanical and tribological properties of the composites, a hardness test was conducted. The results show that increasing the wt% of the reinforcement up to 5wt% increases the microhardness of the composite compared to pure Al sample as listed in Table 1. A pin-on-disc test was also conducted to study the wear rate of the samples. It was found that increasing the wt% of

reinforcement decreases the wear rate of the Al composite with the best values at 0.5 m/s sliding speed and 7.5 wt% of reinforcement.

Tables and Figures

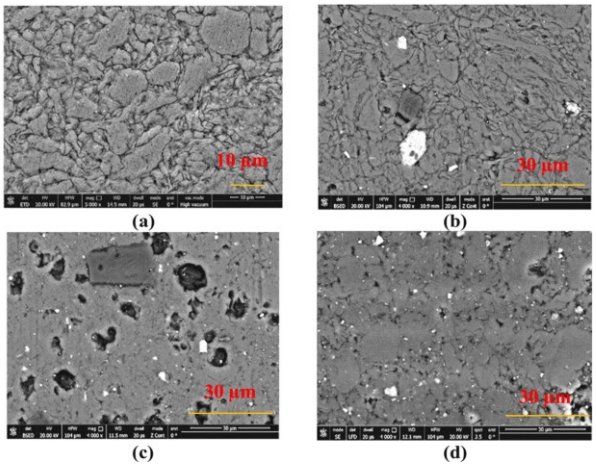

Figure 1 (I) SEM micrographs for (a) pure Al, (b) Al/2.5%(SiC-Y_2O_3)/Ag/Cu, (c) Al/5%(SiC-Y_2O_3)/Ag/Cu and (d) Al/7.5%(SiC-Y_2O_3)/Ag/Cu.

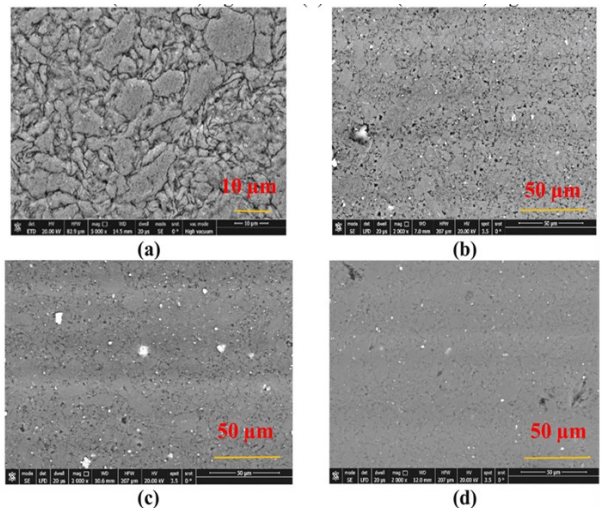

Figure 2 SEM micrographs for (a) pure Al, (b) Al/2.5%(SiC-Y_2O_3)/Ag/Ni, (c) Al/5%(SiC-Y_2O_3)/Ag/Ni and (d) Al/7.5%(SiC-Y_2O_3)/Ag/Ni.

Table 1 Microhardness (HV) values vs. the concentration in wt.% of the reinforcement (SiC-Y_2O_3)/nano-Ag/(Cu or Ni) in matrix of pure Al

Composition	Microhardness, HV	
	Al/ (SiC-Y_2O_3)/nano-Ag/Cu	Al/ (SiC-Y_2O_3)/nano-Ag/Ni
Pure Al	88	88
2.5%(SiC-Y_2O_3)	106	100
5.0%(SiC-Y_2O_3)	132	110
7.5%(SiC-Y_2O_3)	120	108

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