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TRIBOCORROSIO MECHANISMS IN FUNCTIONALLY GRADED ALUMINIUM MATRIX COMPOSITES

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ABSTRACT

Al alloys reinforced with SiC particles (Al-SiC_p composites) have shown a great potential for several industries essentially due to their mechanical resistance. Additionally, by using centrifugal casting technique, it is possible to create a gradual decrease of the amount of reinforcing particles from the surface to the bulk, and therefore to combine surface hardness and higher wear resistance with adequate bulk toughness [1,2].

Artificial aging heat treatments can further increase the mechanical and tribological properties of Al-SiC_p composites, especially in Cu-containing Al alloys [1,3]. Copper is commonly added as alloying element to Al alloys to improve mechanical strength by precipitation hardening. This process consists in the controlled precipitation of Cu-rich precipitates (usually metastable intermetallic Al_2Cu phases - θ'' and θ') in the Al solid solution during heat treatment. Those precipitates constitute obstacles for dislocation movements [4,5,6]. Nevertheless, the presence of Cu has a detrimental effect on the corrosion resistance of these materials [7]. Cu-containing phases (or even the presence of Cu in solid solution) creates a galvanic coupling with the surrounding Al matrix. The Cu-containing phases acts as preferential cathodes for the oxygen reduction reactions thus accelerating the anodic oxidation of aluminium [8-10].

Although wear and corrosion behaviour have been widely studied for Al-SiC_p composite materials, there is few information regarding their tribocorrosion behaviour. Tribocorrosion phenomena appear when a tribological (sliding/rolling) contact occurs in the presence of a corrosive environment, presenting therefore an important practical relevance in different industrial sectors. However, little is known about tribocorrosion behaviour of FGM's Al-SiC_p composites.

The main aim of this work was to investigate the effect of different aging-hardening conditions on the tribocorrosion behaviour of Al-SiC_p functionally graded composites. A home-developed Al-10Si-4.5Cu-2Mg was selected as matrix and SiC particles were used as reinforcement. The composites were processed by centrifugal casting. Post-processing age-hardening treatments were performed. The solution treatment was made at 500 °C (2h and 8h as holding time) followed by quenching and artificial aging (thermostatic silicone bath at 160 °C, during 512min). The corrosion and tribocorrosion tests were carried out in 0.05M NaCl and 0.1M $NaNO_3$ solutions, at 25 °C. The tribocorrosion tests were performed in a reciprocating ball-on-plate tribometer and the friction coefficients as well as relevant electrochemical parameters were monitored during the tests. Non-heat treated samples were also tested to understand the influence of the heat treatment. Tests were done in OCP conditions.

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