XXXI International Conference on
Surface Modification Technologies (SMT31)

JULY 5-7, 2016, MONS, BELGIUM

A SVET INVESTIGATION ON THE CORROSION INHIBITION OF AA2024/GRAPHITE GALVANIC COUPLING

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Abstract

Aluminium alloys and composites have recently been considerably used as structural materials in aeronautics. In particular, new aircraft designs contain increasingly higher amounts of Carbon Fibre-Reinforced polymers (CFRP). However, being carbon fibre electrochemically nobler than aluminium, galvanic couplings can be established in case of aluminium-based alloys connected to the composite material [1,2]. Indeed, such assemblies create favourable conditions for the rise of galvanic corrosion and can become a limiting factor in many complex junctions. Furthermore, due to the health issues concerning Cr(VI)-based anti-corrosion approaches, the aeronautical field urges for the development of new environmentally friendly corrosion inhibitors. The elaboration of efficient inhibitor systems for the galvanic corrosion control between CFRP and aluminium alloys is therefore a subject of prime importance. Corrosion inhibition is a complex process, where inhibitor molecules interact with nano/micrometric local cells formed on an active surface. Therefore, the study of galvanic corrosion and its inhibition mechanisms would ideally require in situ analyses at the lowest possible scales. With the relatively recent advent of local electrochemical techniques, spatially-resolved investigations of corrosion at micro scales have increasingly been considered [3-5]. In particular, the Scanning Vibrating Electrode Technique (SVET) stands out as an important monitoring approach for galvanic coupling inhibition analyses - being widely reported in the literature [6-11].

In the present work, SVET was employed to locally resolve the inhibitive actions of different species on the AA2024/graphite galvanic corrosion. AA2024-T3 was selected as long as it is one of the main structural alloys present in active service aircrafts. Bulk graphite was chosen instead of an actual CFRP material because carbon fibre diameter (typically 3 µm) is below the spatial resolution of SVET. Then, two different AA2024/graphite galvanic coupling models were designed. The first model consists of a graphite rod (3 mm in diameter) mounted in parallel to an alloy plate (1 cm x 0.81 mm), letting a 2 mm gap between them. The second model comprises an AA2024 plate (2 mm x 0.81 mm) mounted in parallel to a graphite foil (2 mm x 0.13 mm) respecting a 1 mm gap (Fig. 1 (a)). Considering that the thickness of CFRP foils is typically a few hundred of microns, the model based on a 0.13 mm thick graphite foil yields more realistic predictions. Then, the following species were evaluated as potential inhibitors of AA2024/graphite galvanic corrosion in neutral aerated NaCl solutions: mercaptobenzothiazole, triethanolamine, benzotriazole, tween 80, cerium chloride, lanthanum nitrate, 8-hydroxyquinoline, manganese chloride, sodium benzoate, glutaric acid and sodium salicylate. Some species, solely and/or combined, presented quite reasonable inhibition efficiencies towards both models (Fig. 1 (b)). The inhibition efficiencies were estimated from the calculation of total anodic currents (surface integral of anodic current densities from SVET maps). Even if SVET was able to furnish insights on the inhibitive actions of different species, further analyses should be performed in view of better comprehending the relying inhibition mechanisms.

Keywords: AA2024; galvanic coupling; graphite; SVET; inhibitors.

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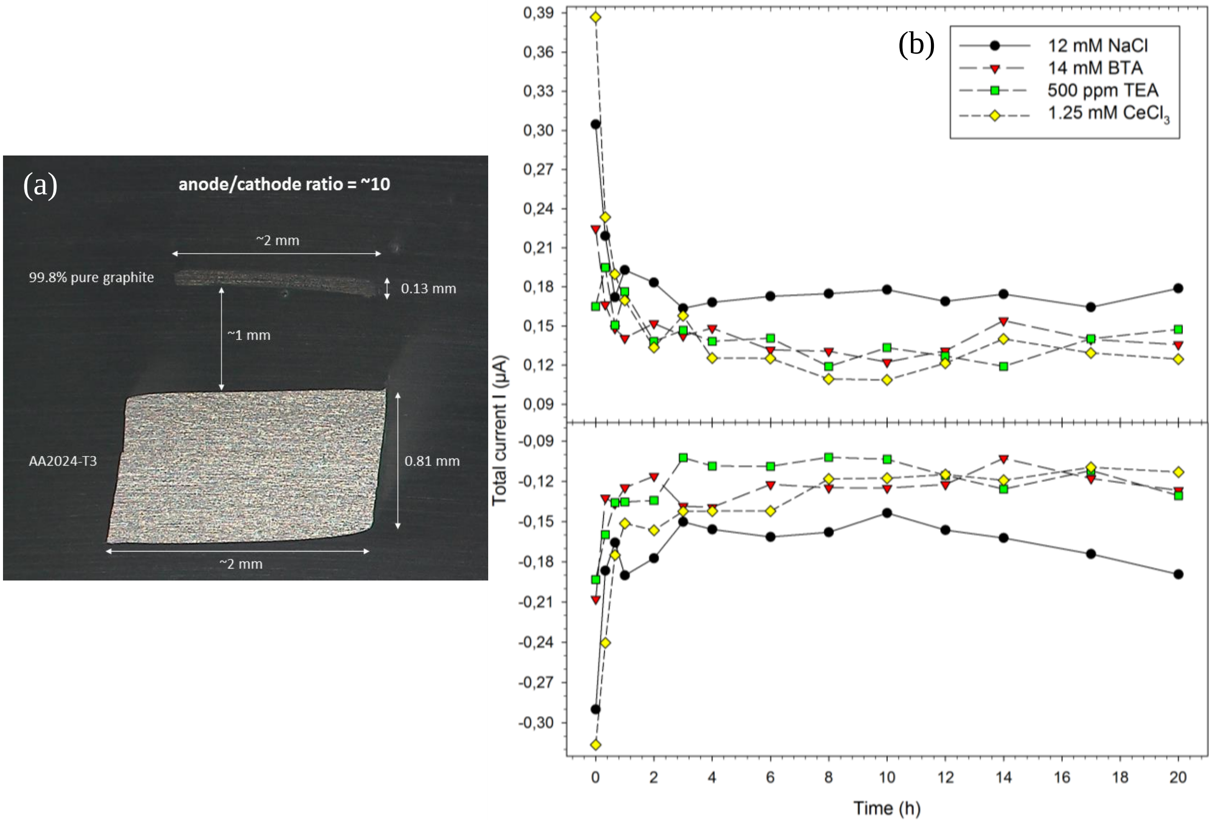

Fig. 1. (a) the AA2024/graphite foil galvanic coupling model employed in this work. (b) SVET total anodic currents (positive) and total cathodic currents (negative) obtained in 12.00 mM NaCl reference solution from the model in the presence of different compounds.

Acknowledgements

The authors acknowledge the Brazilian agency CNPq for financial support in the framework of the Science Without Borders Programme.

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