Corrosion investigation of AISI 316 stainless steel with CNT and CNT-Polymer coating materials under simulated PEMFC working conditions

Mazdak Hashempour[1,2], Antonello Vicenzo[1], Massimiliano Bestetti[1], Surbhi Sharma[2], Daniel Gonzalez[2]

[1] Dipartimento di Chimica, Materiali e Ingegneria Chimica "Giulio Natta" - Politecnico di Milano, Via L. Mancinelli 7, 20131, Milan, Italy

[2] Centre for Hydrogen and Fuel Cell Research, School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK

Among substrate materials showing catalytic activity for carbon nanotube (CNT) growth, i.e. without need of an externally applied catalyst, stainless steel stands out as a very interesting candidate, due to economic justification as well to the remarkable properties of this class of materials. Not surprisingly, direct growth of CNT on stainless steel has been studied by several groups, e.g. [1,2].

A wide and diverse range of applications has been envisaged for CNT coated stainless steel; many of these are related to electrochemical technologies and processes, including electrodes for fuel cells, batteries, supercapacitors and sensing devices, and as a catalyst support for either electrochemical energy devices or electrodes for waste water treatment.

The exposure to aggressive environment in most of the above mentioned applications calls for an in-depth study of the effect of the synthesis condition of filamentous carbon nanostructures on the corrosion behavior of stainless steel (SS), which is the primary objective of the present work. Moreover, the competence of a conductive polymer coating electrodeposited on a bare SS as well as CNT coated SS to modify the corrosion resistance is investigated.

Carbon nanotubes/fibers (CNTs/CNFs) were grown on SS by a direct CVD method. Potentiodynamic and potentiostatic measurements were carried out to evaluate the corrosion resistance of the as prepared materials. Sulfuric acid solution at 80°C was used as the electrolyte. Electrochemical testing conditions were selected so as to simulate the working conditions inside PEM fuel cells. The direct growth of CNT/CNF on stainless steel was found to have deteriorating effects on the corrosion resistance of the substrate due to carbon diffusion into the stainless steel mainly through grain boundaries and thereby, causing the sensitization of the material to intergranular corrosion.

Electrodeposition of a polyaniline (PANI) coating on bare and CNT-SS was investigated in order to improve corrosion resistance. Initial studies of PANI coated materials shows promising results. Further investigation is underway.

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