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Cathodic Plasma Electrolysis: from Surface Pre-Treatment of Metals to Galvanizing

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Cathodic Plasma Electrolysis (CPE) is an electrochemical technique that, while working at atmospheric pressure and temperature, generates at the electrode surface a thin sheath of plasma (Fig.1a) that assures peculiar properties to the treated sample. Unlike the more well-known analogous anodic process (plasma electrolytic oxidation, PEO), also used at an industrial level for growing oxide layers on metal substrates, CPE is still almost at the beginning from a strictly scientific standpoint, with applications ranging from surface cleaning/pre-treatment to coating deposition [1]. Even if peculiar properties of the zinc deposit have been already reported [1], the CPE technology was launched on the market by only one company (CAP Technologies; USA).

Combining the Regenerative and Circular Economy vision with the real needs of steelmaking companies, our research group has started a feasibility study aimed at using CPE for galvanizing secondary steel using Zn-containing aqueous solutions resulting from the leaching of electric arc furnace (EAF) dust that is a waste resulting from the production of secondary steel from galvanized scrap.

In the present talk, some preliminary lab-scale data will be discussed concerning the employment of CPE for both *surface pre-treatment* and *galvanizing* of steel, in the form of plate and wire rod. Special attention will be devoted to ammonium-based solutions, as a still unexplored medium. This choice comes from the good performance of NH_4Cl as zinc leaching agent of EAF dust, by preventing some drawbacks of the conventional approach with sulfuric acid. Through a systematic study, electrolyte nature and concentration, temperature and applied potential have been identified as the most affecting operative parameters for both formation and stability of plasma (Fig.1b). Under optimized working conditions, the effects of CPE on *i*) the surface morphology of the treated steel and *ii*) the features of the zinc deposit have been investigated by combining electrochemical and microscopic techniques, providing effectiveness clues.

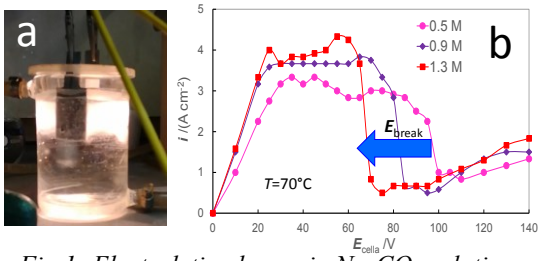

Fig.1: Electrolytic plasma in Na_2CO_3 solution (a); i vs E_{cell} curves going from normal to plasma regime (b).

Reference: [1] *E.I. Meletis et al. Surf. Coat. Tech., 150 (2002) 246–256.*

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