

Optical Interferometry Techniques in Electrochemistry Education

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ABSTRACT

In the present investigation, an optical transducer has been developed for materials testing and evaluation of different electrochemical phenomena. The optical transducer was developed by incorporating methods of holographic interferometry for measuring microscopic deformation and electrochemical techniques for determining the corrosion current of metallic samples in aqueous solutions. In addition, the optical transducer was applied not only as an electrometer for measuring different electrochemical parameters but also, the optical transducer was applied as a 3D-interferometric microscope for detecting different micro-alterations at a metal surface in aqueous solution at a microscopic scale.

Keywords: Optical Transducer, Uniform Corrosion, Localized Corrosion, Corrosion Current Densities, Holographic Interferometry, Optical Corrosion-Meter, Stress Corrosion Cracking, Corrosion Fatigue, Double Layer Capacitance, Alternating Current Impedance.

INTRODUCTION

The author developed an optical transducer in 1988 for materials testing and evaluation of different electrochemical phenomena. The optical transducer was developed based on incorporating methods of holographic interferometry for measuring microscopic deformations and electrochemical techniques for determining electrochemical parameters of samples in aqueous solutions. In addition, the optical transducer was applied not only as an electrometer for measuring different electrochemical parameters but also, the optical transducer was applied as a 3D-interferometric microscope for detecting different micro-alterations at a metal surface in aqueous solution, at a microscopic scale. Initially, the optical transducer was used to determine the mechanochemical behaviors of metals in aqueous solution, i.e., stress corrosion cracking, corrosion fatigue, and hydrogen embrittlement¹⁻⁵. Determinations of the mechanochemical behaviors of metals in aqueous solutions, was based on detecting micro-deformations and measuring the corresponding current density by the optical transducer. Further more, the optical transducer was applied as an optical corrosion-meter⁶⁻⁸ for measuring cathodic deposit and anodic dissolution layers of metals in aqueous solutions. Also, the optical corrosion-meter was utilized to determine the cathodic and anodic current densities which correspond to the cathodic deposit and anodic dissolution layers, respectively. The cathodic and anodic current densities were measured electromagnetically by the optical transducer, rather than electronically by one of the classical methods, i.e, an Ammeter, of measuring the flow of the electronic current in a conductor. In addition, the optical transducer was applied to measure uniform corrosion and localized corrosion on metal surfaces and on substrates covered by organic coatings or crevice assemblies⁸⁻¹⁴. The optical transducer also, was used to document adsorption and desorption phenomena of chemical species on metal surfaces in aqueous solutions¹². Finally, the optical transducer was applied as an electrometer for measuring the double layer capacitance, the alternating current impedance and the corresponding oxide layer thickness of metals in aqueous solution¹⁵⁻¹⁶. Details examples on the above applications of the optical transducer in electrochemistry will be given in the presentation.

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