

Title: Magnetoelectropolishing and High-Voltage Electropolishing of Metals and Alloys

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Abstract

Electropolishing of metals and alloys has been developed for many decades now, with its ascents in recently patented magnetoelectropolishing (MEP) process. Most of electropolishing processes proved its usability for a variety of metallic materials, beginning specifically from austenitic stainless steels, through titanium, nickel, cobalt, copper, and their alloys, including many other metals, such as aluminum and its alloys, intermetallic compounds (nitinol), as well as niobium and tantalum. During MEP the stirring is self-imposed by Lorentz Force as a result of interaction of electric and magnetic fields. The influence of magnetic field on electrochemical process in MEP can be divided into three main categories: (1) the effect of magnetic field on the mass transfer, (2) effect on kinetics of the electrode reaction, and (3) effects relating to morphology and chemistry of the surface after electrodissolution.

The additional external magnetic field applied in the MEP process results in effective modifying the metal surface properties of treated parts in comparison with the properties obtained after a standard electropolishing (EP). During MEP, beneficial modification of oxide layer of treated metals and alloys is obtained. After MEP the protective oxide formed on the surface differs significantly in morphology, homogeneousness, thickness, kind and quantity of foreign species incorporated in it. Concerning the last matter – we found the non-standard conditions of high-voltage electropolishing (HVEP) process (up to 450 V) result in incorporation of some interesting elements from the electrolyte into the surface film. Our studies revealed the copper enrichment of stainless steel, with simultaneous reduction of chromium in the surface layer.

Under magnetoelectropolishing of metallic biomaterials, the corrosion resistance, biocompatibility, osseointegration, endothelialization, cleanability, anti-galling and anti-seizing properties are achieved. Some other advantages of MEP are de-hydrogenation of surface layer and a high increase in fatigue resistance, the effects especially valuable in the parts of small diameters or cross-sections.

Biography

Prof. Tadeusz Hryniewicz, DSc PhD ME CE, has completed his PhD in Mechanical Engineering, Wrocław University of Technology, postdoctoral studies from Chemical Engineering, University of California, Berkeley CA, and worked at Lawrence Berkeley Laboratory; then he obtained DSc habilitation from Wrocław University of Technology. As a Full Professor he has worked as a head of Surface Electrochemistry Division, now BioEngineering and Surface Electrochemistry at the Department of Engineering and Informatics Systems, Faculty of Mechanical Engineering, Koszalin

University of Technology. He is Editor-in-Chief of two international journals, serves as Associate Editor to 12 journals, and Lead Guest Editor to METALS, issue on Plasma Electrolytic Oxidation. He has published a number of articles, over 90 papers in reputed journals, and has been serving as a reviewer to over 50 international journals.

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