Hydrogen Plasma Treatment of Model Corrosion Layers on Bronze

Petra Fojtíková
Lucie Řádková, Filip Mika, František Krčma

Brno University of Technology, Faculty of Chemistry, Institute of Physical and Applied Chemistry
Purkyňova 118, 612 00, Brno, Czech Republic
xcfojtikovap@fch.vutbr.cz

Together with mechanical cleaning, desalination and surface treatment, hydrogen plasma treatment is a part of conservation process of archeological artifacts. Advantages of the method are non-destructivity and no contact with aggressive chemicals. The conservation process has to be performed very specifically, because of uniqueness of every archeological artifact. It is not possible to perform comparative research on real artifacts, therefore using of model samples is necessary. Nowadays, hydrogen plasma treatment is used for iron artifacts. For copper alloys, especially bronze, the optimized conditions during the treatment have not been determined yet. The aim of this study is to determine safety conditions of plasma treatment on bronze model samples. Bronze samples with size of $10 \times 10 \times 5$ mm^3 were used.

The first step was the preparation of model corrosion layers. In order of the defined roughness, the surface of each sample was grinded on an electric grinder with a sandpaper P600. The bronze samples were placed into the dessicator, where they were exposed to hydrochloric acid vapor as a model corrosive environment because chlorine compounds play a typical role as bronze corrosion accelerators. After 14 days, the corrosion process was stopped. The samples were dried and placed to protective argon atmosphere.

Our experimental equipment was constructed according to the design of professor Vepřek, and was further improved. A quartz cylindrical reactor with two outer copper electrodes was used. Plasma discharge was generated in pure hydrogen by a RF generator. Each corroded sample was treated at different conditions (dissipated power and continual or pulsed mode with variable duty cycle). When atomic hydrogen reacts with oxygen from the corrosion layer, OH radicals are produced. Therefore, the relative intensity of OH radicals was monitored by optical emission spectroscopy during the experiment in order to monitor the running process.

The plasma treated samples and one non-treated sample were analyzed by a scanning electron microscope in order to obtain chemical composition by energy dispersive X-ray analysis as well as surface morphology.

Keywords: hydrogen plasma, optical emission spectroscopy, bronze