APPLICATION OF LOW-TEMPERATURE LOW-PRESSURE HYDROGEN PLASMA: TREATMENT OF ARTFICIALLY PREPARED CORROSION LAYERS

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Motivation for this research is the protection of cultural heritage. The plasmachemical treatment of samples with artificially prepared corrosion layers was the aim of this study. These samples had to be used because the basic research is not possible to perform on real archaeological artefacts. Bronze was chosen as a material for the sample preparation.

First mention about plasmachemical reduction method goes back to 70th years of the twentieth century to 2 groups: the first one in London around Daniels [1] and the second in Zürich around Vepřek [2].
Experimental part of the study had 3 main parts: preparation of bronze samples, creation of corrosion layers on these samples and plasmachemical treatment of samples with these layers. Surface of each bronze sample was grinded due to roughness unification of all surfaces. Corrosion layer formation took place in a desiccator with hydrochloric acid vapours and addition of sand. Treatment of samples was carried out in an apparatus which is schematically drawn in Figure 1. Pressure in the reactor was around 160 Pa, flow rate of pure hydrogen was 50 sccm and plasma treatment duration was 90 minutes. The supplied power in a continual or pulsed mode (with varied duty cycle) was setted separately for each sample. Monitoring of the running process was done by optical emission spectroscopy (OES). Rotational temperature was calculated from results of OES. Sample temperature during the experiment was measured by a thermocouple.
Results showed that the reduction process was successful for all samples. Two maxima of relative intensity of OH radicals were recorded in first 15 minutes of the treatment. The first maximum probably corresponded to the reduction process of an outer sandy layer, and the second maximum reflected the reduction of inner corrosion layers in contact with the original surface. The maximal sample temperature increased with increasing effective power.

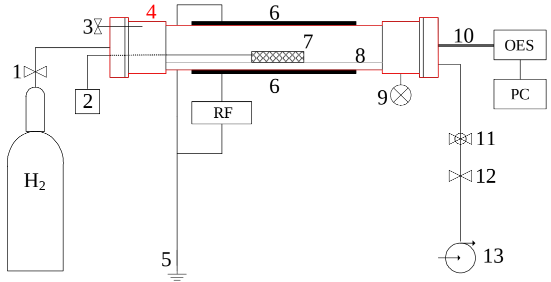

Fig. 1: *Schematic drawing of the apparatus for plasmachemical reduction: 1 – mass flow controller, 2 – thermocouple, 3 – aeration valve, 4 – reactor, 5 – grounding, 6 – 2 copper electrodes, 7 – corroded samples, 8 – glass holder, 9 – pressure gauge, 10 – optical fibre, 11 – ball valve, 12 – electromagnetic valve, 13 – rotary oil pump.*

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References

[1] V.D. Daniels, L. Holland, M.W. Pascoe, *Proc. Studies in Conservation,* 24 (1979) 85-92.
[2] S. Vepřek et al., *Proc. Plasma Chemistry and Plasma Processing,* 5 (1985) 201-209.