Sample temperature during corrosion removal by low-pressure low-temperature hydrogen RF plasma

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1. Introduction

The plasmachemical reduction of corrosion layers from archaeological metallic objects is known since the late 70th [1, 2]. Contemporary, it is used in some museums, but the optimal treatment conditions are not fully known yet. Treated object temperature is one of the most critical points because metalographic changes can be initiated by elevated temperatures and thus the unique historical information can be lost. Temperature increases due to the direct inductive heating in the discharge as well as by the interaction of the surface with plasma active particles. Our contribution shows an overview about maximal temperatures reached during the plasma treatment of various model samples.

2. Experiment and results

Model samples (50x20x10 mm^3) were prepared form the most common archaeological metals (iron, copper, bronze and brass) using hydrochloric acid vapour. Two different sets were created: The first one with pure corrosion layer, the second one with a sand incrustation for a better simulation of the real situation. The plasma treatment was carried out by a low pressure (160 Pa) capacitive coupled hydrogen (flow rate of 50 sccm) RF discharge in a continuous as well as pulsed regime. The sample temperature during the treatment was monitored by a K-type thermocouple installed inside the sample.

The non-incrusted samples temperature increased during the first 30 minutes of the plasma treatment and after that it remained constant. During the treatment of some of the incrusted samples, much faster but only a temporal increase of temperature was observed. After that, the temperature was significantly lower in contrary to the non-incrusted samples. The maximal temperatures during the process are shown in Fig. 1 for the treatment in the continuous regime. It can be seen that the maximal temperature is significantly lower at the lowest applied powers. This is due to the fact that no temperature peak at the process beginning is observed. We are suggesting that the strong temperature enhancement observed during the incrusted samples treatment is connected to the removal of slightly bounded outer corrosion layers (it is confirmed by OES monitoring). Therefore, the incrustation plays a shielding role and thus the plasma active particles do not interact directly with the surface.

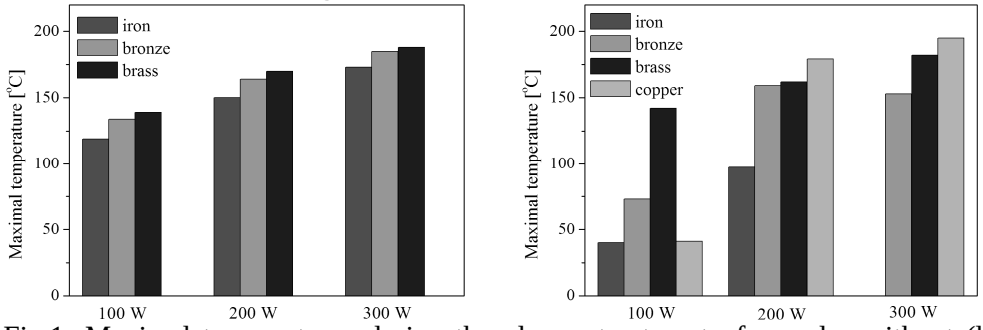

Fig.1: Maximal temperatures during the plasma treatment of samples without (left) and with (right) sandy incrustation layers.

[1] V.D. Daniels, L. Holland, M.W. Pascoe, *Proc. Studies Conserv.*, **24**, (1979), 85-92
[2] S. Veprek et al., *Proc. Plasma Chem. Plasma Proces.*, **5**, (1985), 201-209

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