Plasma immersion ion implantation against corrosion of PbSn organ pipes

Bernadeta Pelic*[1], Felipe Bregolin[1], Slawomir Prucnal[1], Katarzyna Werniewicz[1], Wolfgang Skorupa[1], and Rossen Yankov[1]

[1]Helmholtz Zentrum Dresden-Rossendorf (HZDR) – Germany

Abstract

The present historical organs are musical instruments, which provide sound impression of divine music spanning six centuries. Unfortunately, organ pipes, traditionally made of PbSn alloys, have been severely affected by corrosion in the last couple of centuries, and particularly over the last decades. It is therefore necessary to gain a deeper insight into the potential corrosion risk factors when restoring an organ in order to avoid future corrosive degradation. A new conservation concept based on plasma immersion ion implantation (PIII) is proposed here for the protection of PbSn alloys exposed to high levels of acetic acid vapors (1-5%).
Samples of organ-pipe quality PbSn alloys of compositions of Pb-Sn3, Pb-Sn10, Pb-Sn15-Sb10 and Pb72-Sn28 were processed by PIII of either nitrogen (ion doses of 1E15, 5E15 and 1E16 cm-2) or SF6 (S ion doses of 2E17, 5E17 and 1E18 cm-2) at temperatures not exceeding 100°C, for different times and bias voltages (20-40 kV). The PIII-treated specimens were subsequently studied by Rutherford backscattering spectrometry (RBS) and X-ray photoelectron spectroscopy (XPS) to infer the concentration/depth profiles of the implanted elements. The implant profiles were also simulated with the aid of the SRIM code. Samples were finally examined using an accelerated corrosion tests in an acetic acid ambient.
Both the alloy composition and the implant dose were found to strongly influence the corrosion behaviour of the PbSn alloys. The best corrosion resistance was obtained for samples consisting of Pb-Sn15-Sb10 and Pb-Sn28, after the implantation of nitrogen to a dose of 1E16 cm-2. A protection mechanism was accordingly proposed and discussed.

Keywords: Plasma immersion ion implantation, PbSn alloys, corrosion of organ pipes

*Speaker