

## Controlling pollution effects on metallic cultural heritage using linear sweep voltammetry

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This work demonstrates the potentialities of the linear sweep voltammetry (LSV) for monitoring the composition of the tarnishing layers formed on silver and on the silver-copper alloys exposed to atmospheres contaminated with pollutants, such as H<sub>2</sub>S and chloride ions, among others.

A collection of silver and sterling silver coupons exposed during periods of 1 and 12 months, at the Holy Altar of the Chapel and at the Treasure Room of the Museum, both of the Porto Cathedral (Portugal), with exposures started in march 2010 and ending in march 2011, have been analysed by LSV.

The LSV spectra of blank polished samples as well as samples covered with thin films of silver sulphide and of silver chloride, formed under controlled conditions, respectively: (i) H<sub>2</sub>S, 1000 ppm, RH= 53%±2, T= 21 ±1 °C, over periods of 24, 48 and 72 h and (ii) 3.5% of NaCl, RH= 41% ±2, T= 43 ±2 °C, over period of 5 h, have been used as references.

The influence of the atmosphere (Chapel and Museum), exposure time (1 and 12 months) and season, in which the exposures were started, (spring, summer, autumn and winter) have been analysed on the LSVs of the coupons exposed to the various conditions.

For the 1 month exposures started in spring the peaks corresponding to the silver sulphide and silver chloride were, as expected, higher on the samples exposed in the Chapel. For the 12 months exposures both peaks have increased in size with the peak assigned to chloride being much higher in the case of the Chapel and the inverse behaviour in the case of the Museum. The seasonal influence was particularly notable on those samples with exposures started in beginning of winter, with visible effects on the sulphide and chloride peaks.

The peak attributed to silver sulphide being much higher for the samples exposed in the Museum and the chloride peak for those exposed in the Chapel.

Keywords: silver, sterling silver, Chapel, Museum, tarnishing layers, LSV.

