Article: Evaluation of Atmospheric Afterglow Plasma Treatment with Advanced Electron Microscopy Techniques as a New Sustainable and Minimally Invasive Conservation Treatment for Silver Degradation in Different Historic Photographs (Extended abstract)
Author(s): Eva Grieten, Joost Caen, and Dominique Schryvers
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Evaluation of Atmospheric Afterglow Plasma Treatment with Advanced Electron Microscopy Techniques as a New Sustainable and Minimally Invasive Conservation Treatment for Silver Degradation in Different Historic Photographs

Eva Grieten, Joost Caen, and Dominique Schryvers

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The first step in introducing a new conservation treatment for the conservation of photographs is an in-depth study of the changes made by the treatment to a specific degradation phenomenon and the original image. In this study atmospheric afterglow plasma is evaluated for silver degradation. Two types of photographic techniques, daguerreotype and gelatin silver glass plate negatives, were selected as case studies. Both techniques are sensitive to the degradation of the image; which can often be identified as a discoloration or tarnishing of the image altering the readability and stability of the photograph.

The afterglow plasma technique shows several advantages compared to traditional treatments because it is a local, sustainable, user friendly and a non-contact method. In theory a reductive atmospheric plasma afterglow can selectively remove or alternate the appearance of the tarnish layers from a photograph, enhancing the readability of the image without changing the original image. To evaluate the changes made by the technique, both glass negatives and daguerreotypes are characterized before and after plasma treatment using a multi-analytical approach including scanning electron microscopy (SEM) and (scanning) transmission electron microscopy ((S)TEM) coupled with spectroscopy techniques. By using spectral imaging it is possible to link the chemical composition to the spatial distribution of the corrosion phenomena and map the induced changes. By characterizing both the surface of the photograph as the internal structure the changes in topography and

Fig. 1. Gelatine glass plate negative partly treated with the afterglow treatment *(left)* and partly untreated *(right)*.

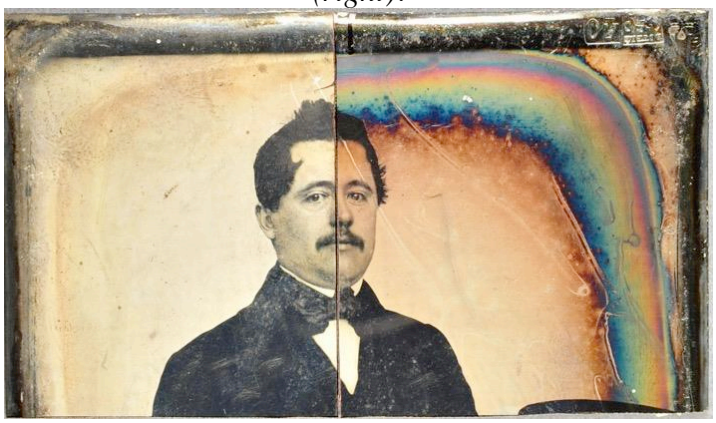

Fig. 2. Daguerreotype before treatment *(right)* and after treatment *(left)*

chemical composition due to the plasma treatment can be evaluated at different length scales. The results show that the plasma treatment is selective removing corrosion compounds and that the morphology of the corrosion layer changes, resulting in an improved readability of the image. In figures 1 and 2 examples are shown of the visual change made by the plasma treatment. Finally we will also pause on how the characterization can help us in evaluating the perception of this possible new conservation treatment for silver degradation.

More in-depth discussion on characterization and methodologies used in this study can be found in the following publications:

- Grieten, E. et al., "Optimal sample preparation to characterize the corrosion in historical photographs with analytical TEM". *Microsc. Microana*, 20, 05, 2014: 1585-1590.
- Earliest photographs analysed at the ESRF, online available in jan. 2016 :http://www.esrf.eu/home/news/general/content-news/general/earliest-photographs-analysed-at-the-esrf.html
- X-rays show first photos in new light (ESRF news)
- Grieten, E. et al., Reclaiming the image of daguerreotypes by atmospheric plasma cleaning, Journal of Cultural heritage, 2016 (review pending).
- Application of atmospheric plasma-jets for the conservation of cultural heritage, ICPS2015 , 22nd international symposium on plasma chemistry, online available on jan2016: http://www.ispc-conference.org/ispcproc/ispc22/P-III-6-20.pdf.

Eva Grieten, Joost Caen, and Dominique Schryvers
University of Antwerp

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