Characterization of 19th Century Daguerreotypes by Nondestructive Analytical Techniques

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The Daguerreotype is considered by most of the historians of photography the first invented technique to produce a permanent image using a photochemical reaction. It was developed in France in the decade 1820-1830 by Louis Jacques Mandé Daguerre (1787-1851) and Joseph-Nicéphore Niépce (1765 – 1833). Daguerre presented this new photographic process to the *Academie des Sciences* de Paris in the session of 7th January 1839. In summary, the process involves the polishing of a silver-coated copper plate and its sensitization with chloride or iodine, exposure to sunlight followed by the image development with heated mercury. The image was then fixed with sodium thiosulfate and a positive photographic image was obtained.

In order to study the morphology and the degradation status of some daguerreotypes, Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) techniques were used. Local chemical composition was evaluated by in-situ nondestructive spectroscopic techniques such as X-Ray Fluorescence Spectroscopy (XRF) and Energy Dispersive X-Ray Spectrometry (SEM/EDS). This multi-analytical approach includes important tools for the characterization of the daguerreotype process as well as for issues related to the restoration and conservation of historical photographic plates.

Microscopic Examination

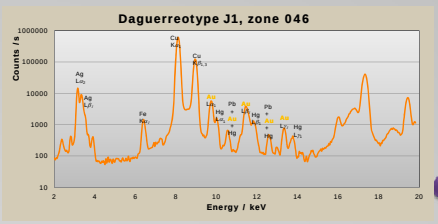
Stereoscopic Zoom Microscope NIKON SMZ1500

- **Magnification**: 70x
- **Illumination**: 45º
- **Exposure and Gain**: constants for each magnification

Qualitative X-ray Fluorescence Spectroscopy

Spectrometer for EDXRF analysis

- X-ray tube (PW 1140; 100 kV, 80 mA) equipped with a molybdenium target and Si (Li) detector
- Energy resolution 135 eV at 5.9 keV
- Commercial pulse processor (Oxford).



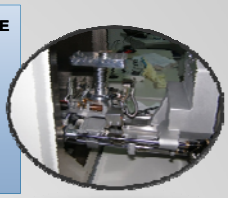
- High density of silver-mercury agglomerates in the highlights
- The surface has a mirror-like aspect
- Toning with gold

Gilded Daguerreotype

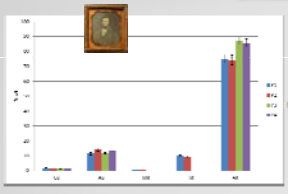
Scanning Electron Microscopy coupled with X-Ray Energy Dispersive Spectrometry (SEM-EDS):

HITACHI S-3700N variable pressure Scanning Electron Microscope (SEM-EDS) coupled with a Bruker X-Ray Energy Dispersive Spectrometer

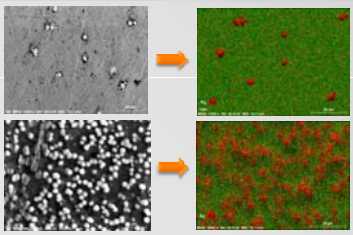
- Acceleration voltage of 20.0 kV and high vacuum conditions.
- Secondary and backscattered electrons imaging mode were used.
- A 20 cm width chamber allows the analysis of the entire photograph avoiding microsampling.



Point analysis



Distribution map of silver and mercury in dark and light areas



Final Notes

- **The microscopic examination revealed morphological details used for the preliminary evaluation of the daguerreotype preservation status and production.**
- **The non-invasive techniques XRF and SEM-EDS allowed elemental analysis to be performed in situ providing relevant information concerning gold toning, the scarce presence of sulfur, a degradation agent, and the methodology used for the daguerreotypes production.**
- **The SEM-EDS analysis gave detailed information about the surface morphology and homogeneity of the daguerreotypes. Point analysis and distribution elemental maps were obtained which provided information about the local chemical composition and the profile of the distribution of the main elements of the daguerreotypes.**

References

- BARGER, S. & WHITE, W. (2000), ***The Daguerreotype: nineteenth-century technology and modern science***, *The John Hopkins University Press, Baltimore and London.*
- DA SILVA, E., ROBINSON, M., Evans, C., PEJOVIC-MILIC, A. and HEYD, D. (2010), **Monitoring the photographic process, degradation and restoration of 21st century Daguerreotypes by wavelength-dispersive X-ray fluorescence spectrometry**, *Journal of Analytical Atomic Spectrometry*, 25, pp. 654-661.
- STULIK, D. & KAPLAN, A. (2010), **An example of complex composite materials and processes: Photography** *in* ARTIOLI, G. (coord), *Scientific Methods and Cultural Heritage: An introduction to the application of materials science to archaeometry and conservation science*, Oxford, University Press, pp. 419-433.

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