Trailblazing findings on the properties of daguerreotypes

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Plasmonic properties of daguerreotypes. Credit: The Metropolitan Museum of Art

The Metropolitan Museum of Art (The Met) and The University of New Mexico (UNM) today announced the groundbreaking findings of a two-year study of the plasmonic properties of daguerreotypes.

Using atomic force microscopy and scanning electron microscopy, together with numerical calculations, the team of scientists from The Met and UNM, in collaboration with Century Darkroom, Toronto was able to determine how the light scattered by the metallic nanoparticles on

the surface of a daguerreotype determines the characteristics of its image, such as shade and color.

The pioneering research— recently published in the journal *PNAS*—not only provides an in-depth understanding of these 19th century photographs that are crucial for their preservation, but also introduces new possible approaches for color printing where nanostructures are directly manufactured by light.

"We are thrilled by these findings that help us better understand the fascinating properties of daguerreotypes and shed light on how to continue to advance the preservation of these incredible works of art," said Silvia A. Centeno, Research Scientist in the Department of Scientific Research at The Metropolitan Museum of Art.

"The team at the University of New Mexico embarked on this study to achieve a better understanding of the mechanisms that give rise to the optical response of daguerreotypes and to contribute to the development of protocols for preserving these fragile artifacts," said Alejandro Manjavacas from the Department of Physics and Astronomy at The University of New Mexico. "Thanks to the fantastic teamwork between scientists from both the cultural and scientific communities we were able to accomplish what we set out to do."

Unlike other types of photographs, daguerreotypes rely on light scattering by metallic nanoparticles to create images that project off a reflective silver substrate. These early photographs can be recognized as the first examples of plasmonic color printing, an emerging research field that exploits the interactions between light and metallic nanostructures to produce vivid colors.

The image tones of a daguerreotype are dynamic and unique in that they can change with the viewing angle and, for the first time, this effect is

explained by the authors, who found that the morphology and size of nanoparticles determines how these will scatter thus creating the visual outcome of the daguerreotype. Studies of the image properties of daguerreotypes serve to inform the development of preservation protocols, as well as novel approaches to future color printing technologies inspired by past ones.

More information: Andrea E. Schlather el al., "Nineteenth-century nanotechnology: The plasmonic properties of daguerreotypes," *PNAS* (2019). www.pnas.org/cgi/doi/10.1073/pnas.1904331116

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