

Macroscopic mapping of Lead white pigments in Rembrandt's Nightwatch by means of X-ray diffraction

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Up until the 19th century lead white used to be the dominant white pigment employed in easel paintings. Lead white was usually produced by the Dutch stack process, resulting in a specific proportion of two crystalline lead carbonates, cerussite (PbCO_3) and hydrocerussite ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$). Adjustments to the synthesis parameters or additional post-process treatments would cause the relative abundance of these two phases to change, leading to a pigment with different chemical and optical properties.¹ Previous analyses on micrometric cross-sections has shown that different subtypes of lead white can indeed be identified.

A mobile instrument for macroscopic X-ray powder diffraction (MA-XRPD) imaging has been developed capable of visualizing the distribution of crystalline compounds in painted works of art; abundance ratio's between several of these can be quantitatively estimated.² We have used this instrument to characterize the different lead white subtypes present in Vermeer's painting *Girl with a Pearl Earring*, revealing up to four distinct lead white compositions. This suggests that Vermeer was well aware of the distinctive optical properties of various types of lead white and was highly discriminating in using them in his paintings.³

Recently we have employed the MA-XRPD scanner to investigate a number of subareas of Rembrandt's masterwork 'The Nightwatch'. This investigation is part of a larger characterization study called *Operation Nightwatch* that involves multiple non-invasive imaging methods and the analysis of multiple paint samples from key locations of the famous painting.

In this contribution we will focus on which lead white types could be identified by MA-XRPD in a number of the faces and clothing of the principal figures depicted in this painting. Next to lead white consisting of the usual components hydrocerussite and cerussite, also the less prevalent compound plumbonacrite was found to be present at various locations.

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