

Vermeer's discriminating use of lead white pigments in *Girl with a Pearl Earring*, as revealed by macroscopic XRPD

S. De Meyer,¹ F. Vanmeert,¹ R. Vertongen¹, A. Van Loon², V. Gonzalez^{3,4},
A. Vandivere², G. Van der Snickt¹, K. Janssens,¹ K. Dooley,⁵ and J. Delaney⁵

¹ *University of Antwerp, Department of Chemistry, AXES research group, Groenenborgerlaan 171, B-2020 Antwerp, Belgium*

² *Mauritshuis, Plein 29, 2511 CS The Hague, The Netherlands*

³ *Rijksmuseum, Museumstraat 1, 1070 DN Amsterdam, The Netherlands*

⁴ *Department of Materials Science and Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands*

⁵ *Scientific Research Department, National Gallery of Art, Washington, DC, 20565*

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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. However, such a sample-based, invasive approach damages the original painting and introduces problems of representativeness.

Recently 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 In this study MA-XRPD is used in reflection- and transmission-mode to characterize the different lead white subtypes present in Vermeer's painting *Girl with a Pearl Earring*. In reflection-mode information on the superficial composition is obtained while in transmission-mode the entire stratigraphy is probed. The hydrocerussite distribution obtained with MA-XRPD is very similar to that obtained by means of hyperspectral imaging. The two MA-XRPD variants allowed us to identify and visualize at least three different lead white subtypes used by Vermeer. Furthermore, a fourth lead white subtype was revealed by analysis of carefully selected cross-sections with synchrotron μ -XRPD. 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.

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