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POSTER ABSTRACT

Visualising cyclododecane on porous materials using cryogenic scanning electron microscopy

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Since its introduction in the mid-1990s, cyclododecane (CDD) has found increasing use in the field of conservation. Publications describe its use on a variety of porous and non-porous substrates to facilitate stabilisation, transport and treatment procedures. However, the physical effects of deposition and sublimation remain somewhat unexplained.

This study explores the physical interaction of cyclododecane with porous substrates commonly encountered among cultural materials: paper, wood and clay. It expands upon a study by Riedl and Hilbert (1998) that investigated the interaction between CDD and plaster using cryogenic scanning electron microscopy (cryo-SEM). Due to its low vapour pressure, CDD cannot be imaged with conventional SEM; the vacuum forces sublimation. Cryogenic conditions in the SEM enable imaging of the material, since CDD remains in a solid physical state at low temperatures. The present study was aimed at visualising whether the consolidant lined or filled pores, as well as whether it formed a uniform coating or an open network within pores.

Untreated 1.3 mm diameter samples of Whatman filter paper (grade 3), unfinished oak veneer and self-hardening Critter® clay were imaged using conventional SEM. A second set of substrate samples was consolidated with a solvent application of CDD (80% w/v in Shellsol® OMS) and imaged under cryogenic conditions. An empty gold planchette (1.4 mm), intended to represent a large single pore of an inert substrate (e.g. insect-damaged wood), was also imaged before and after consolidation.

Comparing images of untreated and treated clay, wood, and paper samples reveals that the CDD forms a fairly uniform coating that closely mimics the topography of the substrate. The fine clay surface was completely covered with a smooth, tile-like coating of CDD (Figure 1). The characteristic cellular structure of wood could be seen through the coating layer on the oak veneer, which closely followed the contours (Figure 2). The projecting fibres of the paper were individually encased in CDD (Figure 3). Cracking and delamination of the coating was sometimes observed and may be related to the plunge-freezing process. Only a small amount of CDD was seen within the well of the gold planchette intended to represent a single pore, suggesting that the CDD was not easily retained by the smooth metal surface and that plunge freezing was enough to dislodge the majority from the well. The CDD that remained appeared crystalline and angular.

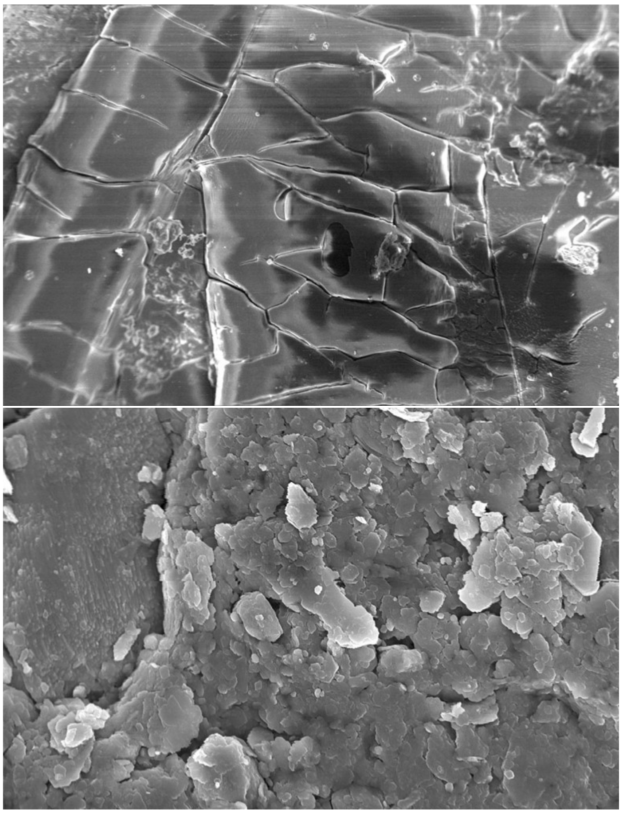

Figure 1 Critter® clay, 10 kV. Coated (2000×, top) and uncoated (5000×, bottom) with CDD.

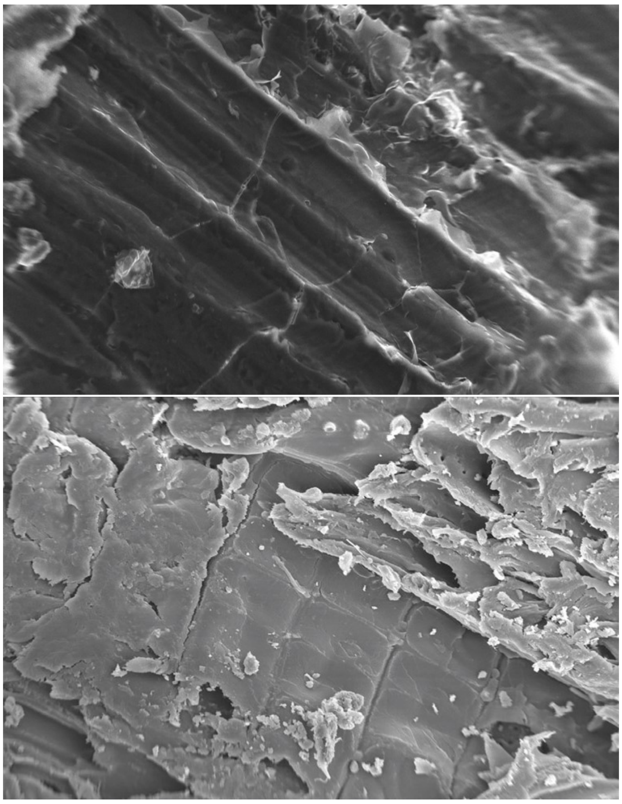

Figure 2 Oak wood, 10 kV, 1000×. Coated (top) and uncoated (bottom) with CDD.

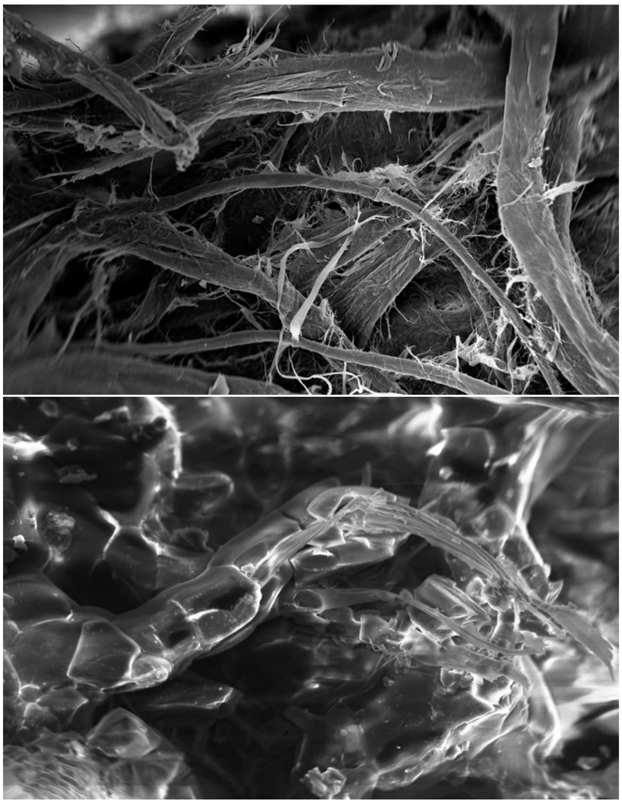

Figure 3 Filter paper, 10 kV, 1000×. Coated (top) and uncoated (bottom) with CDD.

Cryo-SEM proved limited in its ability to peer into the pores of the treated substrates because the cryogenic stage does not offer enough rotation to significantly alter the viewing angle. The treated samples themselves were too small to be easily manipulated and/or cross-sectioned, particularly while maintaining frozen conditions. Because only the topmost sample surfaces were observed, it was not possible to assess the depth of consolidant penetration or the force exerted by the consolidant upon the substrate.

This study permitted an assessment of the physical interaction between CDD and the surfaces of treated substrates, revealing a close correspondence and suggesting thorough coverage of porous materials when the consolidant is applied as a saturated solvent solution.

Biographies

Courtney VonStein Murray is Associate Objects Conservator at Midwest Art Conservation Center in Minneapolis, Minnesota, a regional centre that serves over 200 non-profit institutions, including museums, libraries, historical societies, Native cultural centers, artists and city governments. She is responsible for conservation treatment, preventive care, technical analysis, and collections surveys for three-dimensional objects. Murray holds a Master of Science in Conservation from the Winterthur/University of Delaware Program in Art Conservation and a Bachelor of Arts in Chemistry from Emory University. She is a Professional Associate of the American Institute for Conservation of Historic and Artistic Works and a member of the International Council of Museums-Committee for Conservation.

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Renée A. Stein is Chief Conservator at the Michael C. Carlos Museum at Emory University, where she oversees the treatment, preventive care, and technical analysis of the Museum's diverse collections. She is also a Lecturer in the art history department and teaches courses on conservation and technical study. Stein received a Master of Science specialising in objects conservation from the Winterthur/University of Delaware Program in Art Conservation. She is a Professional Associate of the American Institute for Conservation of Historic and Artistic Works and has been recognised with that organisation's Sheldon and Caroline Keck Award for outstanding mentoring.

Jeannette Taylor is Technologist II in the Robert P. Apkarian Integrated Electron Microscopy Core Facility at Emory University. She is a transmission electron microscope (TEM) and scanning electron microscope (SEM) operator and specialises in cryo-SEM. She has a Masters of Science in Biology from Georgia State University.

References

Riedl, N. and Hilbert, G. (1998), 'Cyclododecan im Putzgefüge: Materialeigenschaften und Konsequenzen für die Anwendung in der Restaurierung', *Restauro* **104**, pp. 494–499.