

## 87100 Cyclododecane (C<sub>12</sub>H<sub>24</sub>), sealing wax

### The use of Cyclododecane as a temporary Consolidant

Renée Stein and Jocelyn Kimmel, Sherman Fairchild Center for Objects Conservation, The Cloisters. Cyclododecane is a cyclic hydrocarbon solid, consisting of large translucent white crystals with a waxy texture. Cyclododecane is readily soluble in nonpolar and aromatic solvents, and is poorly soluble in polar solvents. It is insoluble in water and therefore exhibits strong hydrophobicity. Cyclododecane is solid at room temperature, with a melting point of about 65°C. With continued exposure to air, the solid will completely disappear through sublimation (passing from solid to gas without forming a liquid phase).

### Use

Cyclododecane has been widely used in Germany as a temporary treatment for weak or friable materials, including textiles, paintings, and stone. It has been used as a facing adhesive, release agent, and consolidant for paint. Its use has facilitated the excavation of archeological materials, the removal of mold-making compounds, the cleaning of medieval stained glass, and the general treatment of wall plasters. It has been used to temporarily stabilize paintings and objects in preparation for handling and transport. The hydrophobic solid has been applied as a barrier layer or stop-out over water-sensitive design materials to protect them during aqueous cleaning. It has been tested in the cleaning of soiled glue-bound paint layers, protecting them during subsequent cleaning with a moderately-polar solvent.

### Application

- Cyclododecane can be applied as a melted solid, using a brush, heated spatula, or hot-glue gun.
- It may be dissolved in a non-polar or aromatic solvent and applied as a saturated solution. The solution can be painted or sprayed onto the surface, or it may be injected with a syringe.
- The choice of delivery method should be guided by the condition of the substrate, desired effects of coating and penetration, as well as the toxicity, volatility, and migration of solvents.
- Sublimation can be delayed by sealing the object in an air-tight environment or by covering the object with plastic. Conversely, sublimation can be hastened by increasing direct or indirect ventilation and/or temperature.

## Working properties and practical notes

- Melted cyclododecane forms a thick opaque coating, which cools on the surface of the object without appreciable penetration, unless the object is heated before coating. The molten cyclododecane hardens quickly, so brushing time is limited.
- The concentration of saturated solutions varies with individual solvents, thus the amount of consolidant delivered by a given volume of saturated solution will vary with solvent choice. We found that a saturated solution of cyclododecane in Shellsol 71 is ~83% wt./ wt., while a solution in hexanes is ~135% wt./ wt..
- Saturated solvent solutions are very mobile and easily applied by brush. Spray and injection application are options, but fast-evaporating solvents may result in clogged needles and nozzles.
- No tidelines are formed.
- The size and pattern of cyclododecane crystals formed on the object's surface as the solvent evaporates appear to vary with the solvent choice. Slower evaporating solvents encourage the formation of longer needle-like crystals with a more open lattice network.
- Current research in Germany examines the crystallization of cyclododecane within pore structures.
- Sublimation time appears to be affected by both substrate porosity and delivery method. It is not yet known how much time is required for cyclododecane to leave the substrate.
- Direct heat from a hot air gun will force sublimation.

Reference: G. Hilby "Das Flüchtige Bindemittel Cyclododecan", *Restauro*, 2 (1997) 96-103.

Cyclododecane is a volatile, reversible sealing wax.

Cyclododecane may be melted or dissolved in suitable solvents and applied onto or into the pre-warmed surface.

Examples of applications are:

- Protection during transportation (cyclododecane may be melted and applied thickly)
- Cleaning of water-sensitive surfaces or partial cleaning, etc.

Cyclododecane may be solved in solvents such as iso-octane or naphthas with low boiling points (e.g. 60 - 90°C).

Cyclododecane is being considered non-toxic.

Melting point:	58 - 61°C
Boiling point:	243°C
Flash point:	98°C
Ignition temperature:	265°C
Vapor pressure:	(20°C) approx. 0.1 hPa