



**CONSTGLASS**



Table of results



## 1- Pilot Object

**Pilot object:**

The *Crowning Virgin and the 12 apostles*, LE MANS  
Bay XVI, panel 10

**Picture**



**Identification of the panel:**

Bay: XVI

Panel: 10

Internal face, transmitted light


Internal face, reflected light

**Treatment:**

- 1974, by Gruber studio.

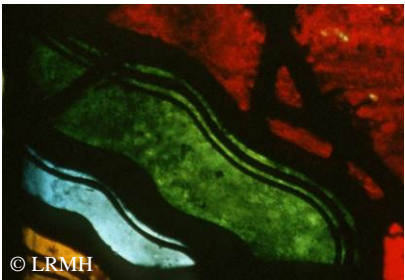

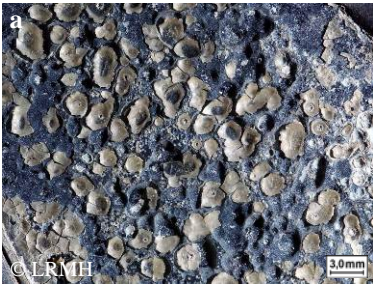
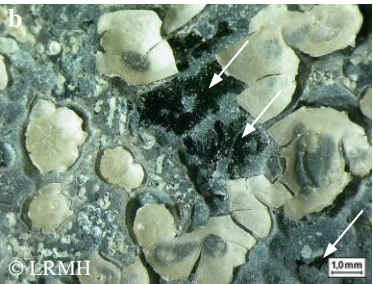
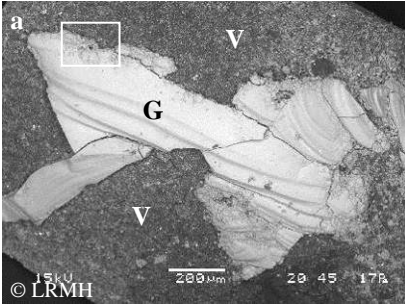
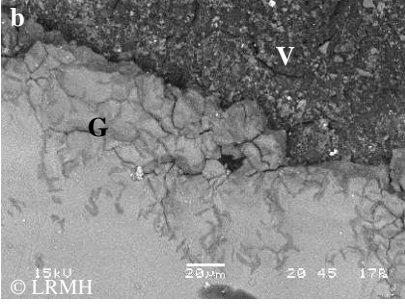
- Product: polyurethane resin (80% Viacryl® VC363 + 20% Desmodur® N75).

- Application: with a soft brush after cleaning.

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## 2-Results

**Sample reference:** *CHA\_bXVIp10\_E\_v1 : green glass, coated with Viacryl® on external surface*



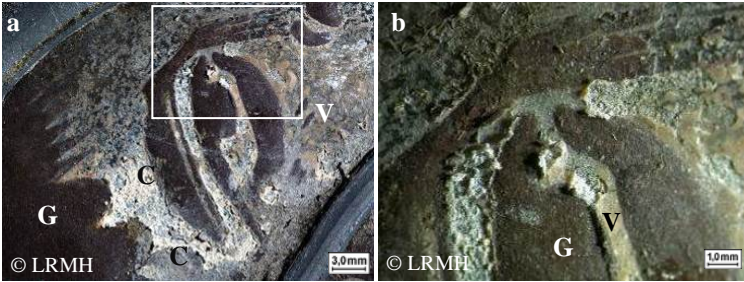
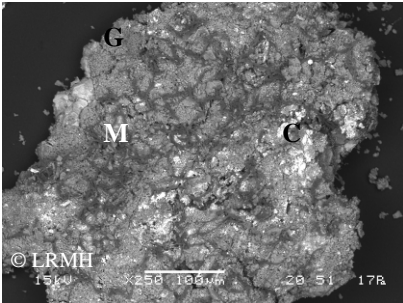
Questions	Techniques	Answers	
<p><b>Morphology</b></p> <ul style="list-style-type: none"> <li>- What is the morphology of the weathered coating?</li> <li>- How is the bonding between coating and glass?</li> </ul> <div style="display: flex; flex-direction: column; align-items: center;">  <p>© LRMH <i>Transmitted light, internal surface</i></p>  <p>© LRMH <i>Reflected light, external surface</i></p> </div>	<p><b>Optical Microscope</b></p>	<div style="display: flex; justify-content: space-around;">   </div> <p>© LRMH      © LRMH</p> <p><i>a - Viacryl flakes in glass craters.      b - Detail of the glass surface.</i></p> <p>On most of the pieces, Viacryl® has been washed away by rain and wind. Here, a large part is still in the craters: we can see the film has been retracted when hardened; it is yellowing and has a milky aspect. In some craters, healthy glass is bared (<b>b-</b>, arrows).</p>	
	<p><b>SEM</b></p>	<div style="display: flex; flex-direction: column;">   </div> <p>© LRMH      © LRMH</p> <p><i>a - internal face of the flake. The healthy glass (G) has been torn off with Viacryl® (V). There is not much corrosion products (the white rectangle locates image b-).</i></p> <p><i>b - Glass on the contact of Viacryl®</i></p> <p>A higher magnification highlights the cracks in the gel layer at the surface of the glass.</p>	<p>A flake of Viacryl® has been sampled on the external face.</p>
	<p><b>Desktop tomography</b></p>		<i>Not foreseen in this case</i>
	<p><b>Phase-contrast tomography on Synchrotron</b></p>		<i>Not foreseen in this case</i>
<p><b>Chemical Composition</b></p> <ul style="list-style-type: none"> <li>- What is the chemical composition of the alteration products?</li> </ul>	<p><b>SEM/EDX</b></p>	<p>The gel layer is a stratum of glass depleted in alkali and alkaline earth metal.</p>	




<p><b>Organic component composition</b></p>	<p><b>FTIR</b></p>	<p>The weathered Viacryl® film present a major reduction of the secondary amid functions (peak at 1527 <math>\text{cm}^{-1}</math>), and an increase of primary amides (a major peak around 1680 <math>\text{cm}^{-1}</math> and a low pic at 1603 <math>\text{cm}^{-1}</math>).</p> <p>© LRMH</p> <p><i>FTIR spectra of Viacryl® films. The black spectrum corresponds to a sample made in 2005 on the panel 10 (naturally weathered Viacryl® film) ; The blue spectrum was undertaken by Jean-Marie Bettembourg in 1983 on a test sample made in 1981 (naturally aged during 20 month in a box, so considered as a fresh sample).</i></p>
	<p><b>RAMAN</b></p>	
<p><b>Microbiology</b></p>	<p><b>Molecular biology, ATP measurements</b></p>	<p>See sample “microbiology tests” at the end of this data sheet.</p>
<p><b>Reversibility</b></p>	<p><b>Test studies Elimination</b></p>	<p>Not foreseen in this case, see sample v2</p>
<p><b>Re-treatability</b></p>	<p><b>Test studies Re-treatability</b></p>	<p>No re-treatability was recommended. An external protective glazing was installed in 2008, by Debitus studio (Tours, 37).</p>

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**Sample reference:** *CHA\_bXVIp10\_I\_v2 : red glass, consolidated with Viacryl® on internal surface*


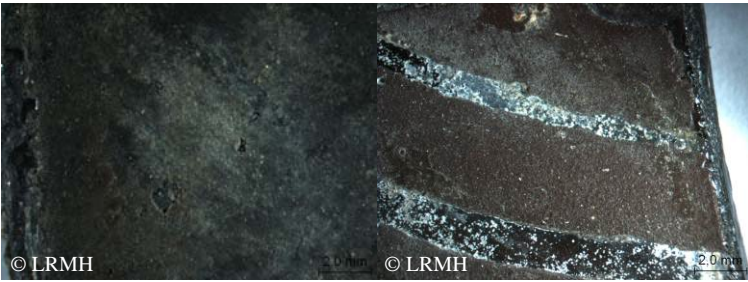
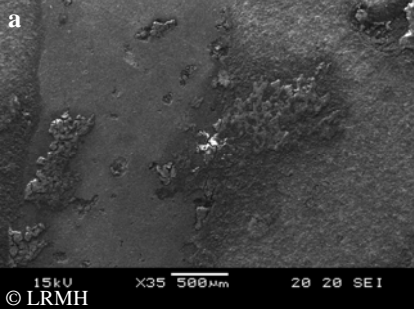
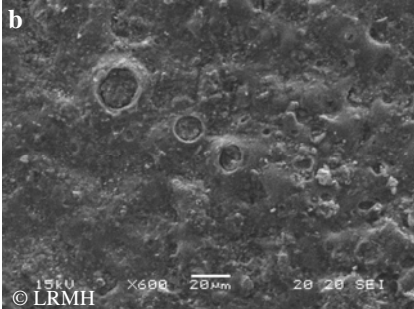
Questions	Techniques	Answers
<p><b>Morphology</b></p> <ul style="list-style-type: none"> <li>- What is the morphology of the weathered coating?</li> <li>- How is the bonding between coating and glass?</li> </ul>  <p>© LRMH <i>Transmitted light, internal surface</i></p>  <p>© LRMH <i>Reflected light, internal surface</i></p>	<p><b>Optical Microscope</b></p>	 <p><b>a</b> – Viacryl® on glass and grisaille. It's flaking where corrosion has restarted. <b>b</b> - Detail of the Viacryl® delamination on glass corrosion products</p> <p>Most of the grisaille has a good shape on the glass. But on some areas, corrosion products are emerging on the glass and the paint, pushing away the Viacryl®. It is hard to say if this phenomenon takes off the grisaille from its support.</p>
	<p><b>SEM</b></p>	 <p>Corrosion products (C) under Viacryl® have been sampled on the weathered glass (G).</p> <p><i>Internal surface of Viacryl® film: between film and glass.</i></p> <p>In addition to gypsum, some micro-organisms (M) are visible on this SEM picture. They are not active anymore, but their presence is an indication of a favourable environment for their growth.</p>
	<p><b>Desktop tomography</b></p>	<p><i>Not foreseen in this case</i></p>
	<p><b>Phase-contrast tomography on Synchrotron</b></p>	<p><i>Not foreseen in this case</i></p>
<p><b>Chemical Composition</b></p> <ul style="list-style-type: none"> <li>- What is the chemical composition of the alteration products?</li> </ul>	<p><b>SEM/EDX</b></p>	<p>The main component of corrosion products is gypsum. It comes from alteration of the glass or alteration of rests of putty.</p>
<p><b>Organic component composition</b></p>	<p><b>FTIR</b> <b>RAMAN</b></p>	<p><i>Not foreseen in this case, see sample v1</i></p>
<p><b>Microbiology</b></p>	<p><b>Molecular biology, ATP measurements</b></p>	<p><i>See sample "microbiology tests" at the end of this data sheet.</i></p>




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<b>Reversibility</b>	<b>Test studies Elimination</b>	<p>The restoration has been made in 2005 by Pivet studio (Morthemer, 86). N-methyl-2-pyrrolidone has been used to remove corrosion products and Viacryl® on glass in internal surface.</p>  <p>Viacryl® and most of corrosion products have been cleaned, the grisaille is still in a good state of conservation.</p>
<b>Re-treatability</b>	<b>Test studies Re-treatability</b>	<p>No re-treatability was recommended. An external protective glazing was installed in 2008, by Debitus studio (Tours, 37).</p>

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<b>Sample reference:</b>	<i>CHA_bXVIp10_I_v13 : purple glass, consolidated with Viacryl® on internal surface</i>
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Questions	Techniques	Answers
<p><b>Morphology</b></p> <ul style="list-style-type: none"> <li>- What is the morphology of the weathered coating?</li> <li>- How is the bonding between coating and glass?</li> </ul>  <p>© LRMH</p> <p><i>Reflected light, after cleaning on the right area</i></p>	<p><b>Optical Microscope</b></p>	<p>This piece was sampled to observe the impact of the cleaning on the grisaille which is thick and has a good adherence.</p>  <p>© LRMH 10µm © LRMH 20µm</p> <p><i>Corrosion products with Viacryl® film (a-), and a cleaned area (b-). The cleaning permits to reveal a smooth or altered (by white pits) glass and a rough paint. It remains Viacryl® on some little areas.</i></p>
	<p><b>SEM</b></p>	 <p>a- Cleaned area of the internal surface: glass and grisaille (Secondary Electron view: information on the shape of the surface).</p>  <p>b- Detail of the grisaille surface after cleaning (Secondary Electron view)</p> <p>The SEM-SE view confirms the glass is smooth, except some cracks due to its alteration. A higher magnification indicates the grisaille is spongy. It's due to bubbles which exploded when cooking. Despite its porosity, the grisaille seems not to be damaged by the cleaning. But the comparison before/after cleaning was not possible because of the Viacryl® and dust.</p>
	<p><b>Desktop tomography</b></p>	<p><i>Not foreseen in this case</i></p>
	<p><b>Phase-contrast tomography on Synchrotron</b></p>	<p><i>Not foreseen in this case</i></p>

		
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<b>Chemical Composition</b> <i>- What is the chemical composition of the alteration products?</i>	<b>SEM/EDX</b>	The main component of corrosion products is gypsum. It comes from alteration of the glass or alteration of rests of putty.
<b>Organic component composition</b>	<b>FTIR</b> <b>RAMAN</b>	<i>Not foreseen in this case, see sample v2</i>
<b>Microbiology</b>	<b>Molecular biology, ATP measurements</b>	<i>See sample "microbiology tests" at the end of this data sheet.</i>
<b>Reversibility</b>	<b>Test studies Elimination</b>	The restoration has been made in 2005 by Pivet (Morthemer, 86) studio. N-methyl-2-pyrrolidone has been used to remove corrosion products and Viacryl® on glass in internal surface. ( <i>see observations below</i> )
<b>Re-treatability</b>	<b>Test studies Re-treatability</b>	No re-treatability was recommended. An external protective glazing was installed in 2008, by Debitus studio (Tours, 37).

<b>Sample reference</b>	<i>Microbiology tests</i>
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<b>Questions</b>	<b>Techniques</b>	<b>Answers</b>
<b>Microbiology</b> <i>- Is there a biological contamination?</i> <i>- Is there an active infestation?</i>	<b>Molecular biology, ATP measurements</b>	No fungi, no Bacteria, no biological activity. Microbiological susceptibility has not been tested: no fresh product.

**Conclusion:** On the external face, it remains not much Viacryl®. But microscope and SEM observations show the Viacryl® takes off the gel layer and the healthy glass when the film is cleaned by rainwater. In 2005, the rests of Polymer has been removed to avoid these problems.

On the internal face, the consolidation is still good on most of the paints. Where corrosion products are on the glass paint, they don't seem to have an impact, because in this case they seem to come from alteration of the putty. If they were coming from the glass, it would damage the paint. The excess of Viacryl® on glass is no more effective because of alteration growing.