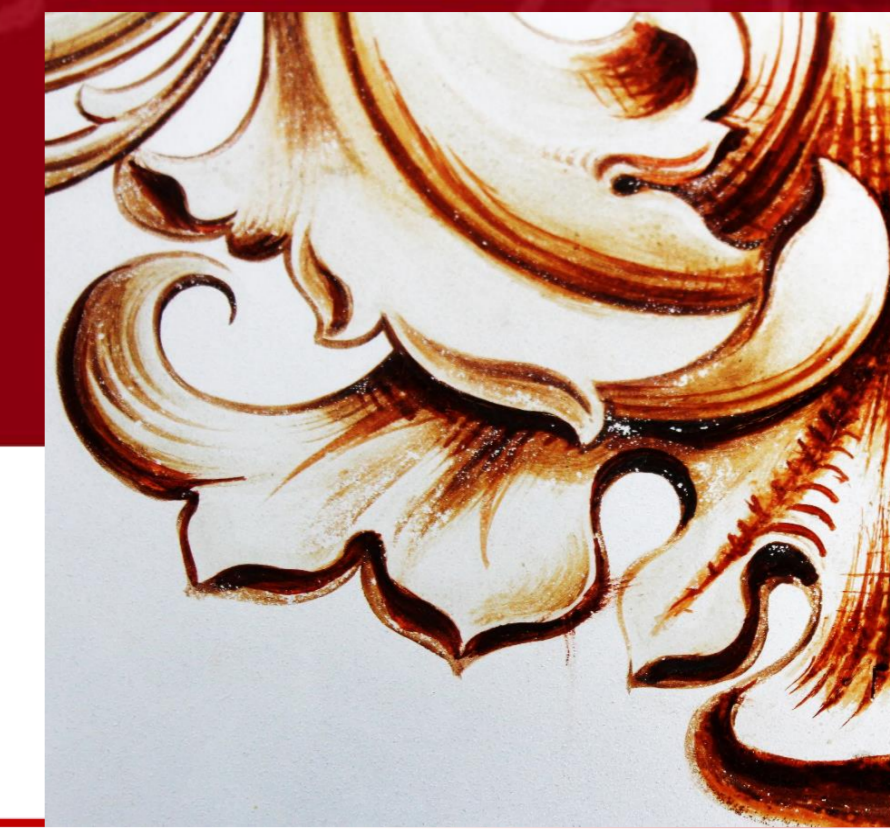


## History of materials: a new tool for conservation of glass and ceramics



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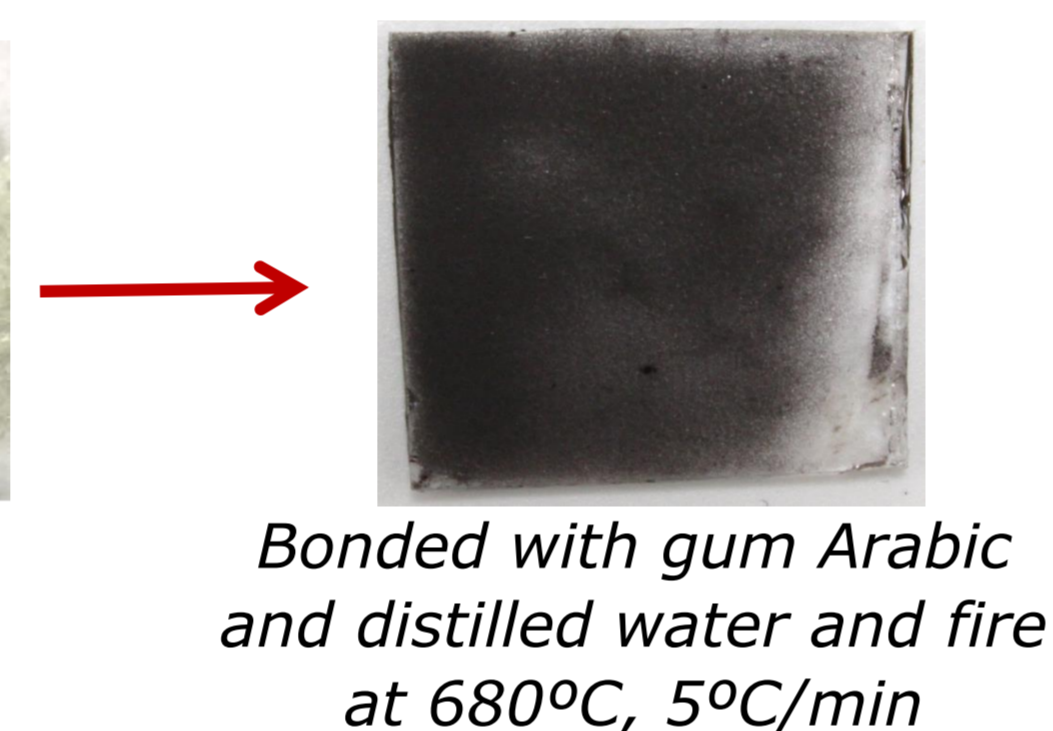
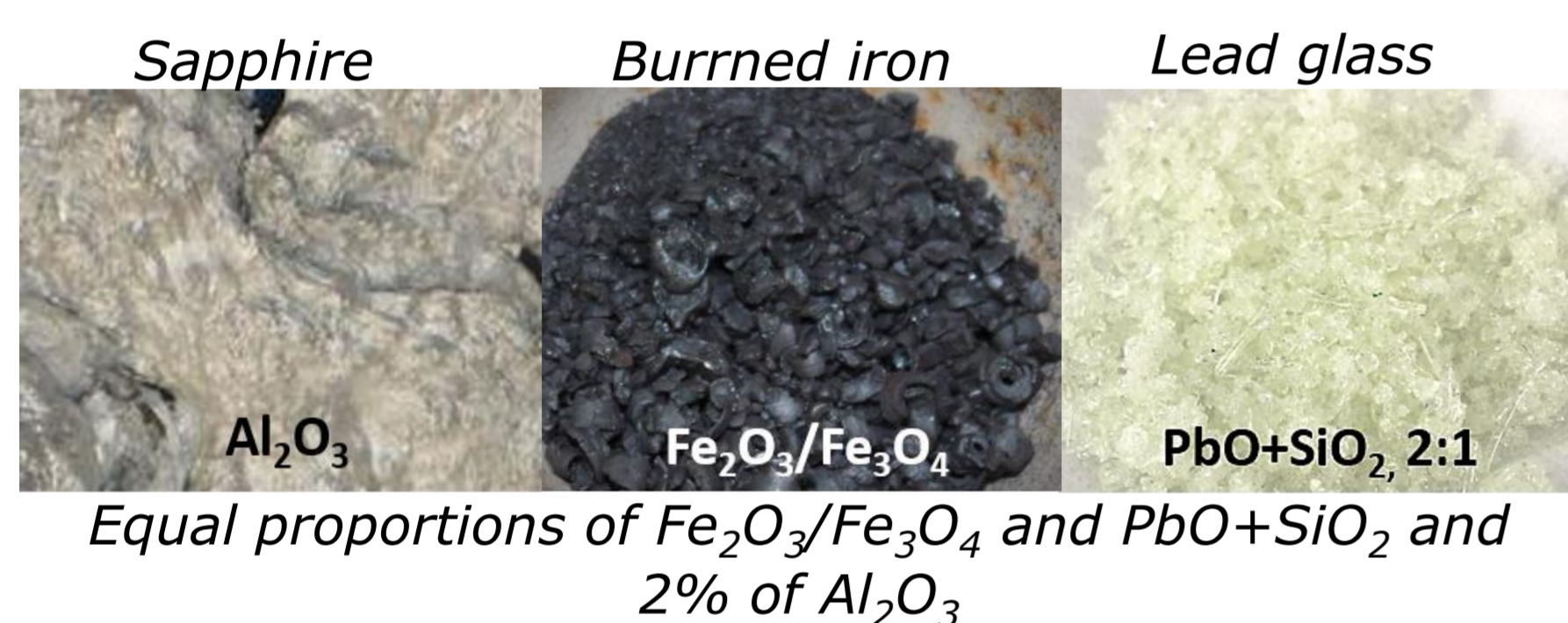
### Introduction

In conservation and restoration of historical objects, it is crucial to have a deep knowledge on the materials and techniques used in its production and in the conservation treatments over time, in order to understand the chemical and physical properties as well as the ageing behavior of the applied materials. Therefore, the Laboratory of Glass and Ceramics from the Department of Conservation and Restoration – FCT NOVA has several ongoing studies related to these issues.

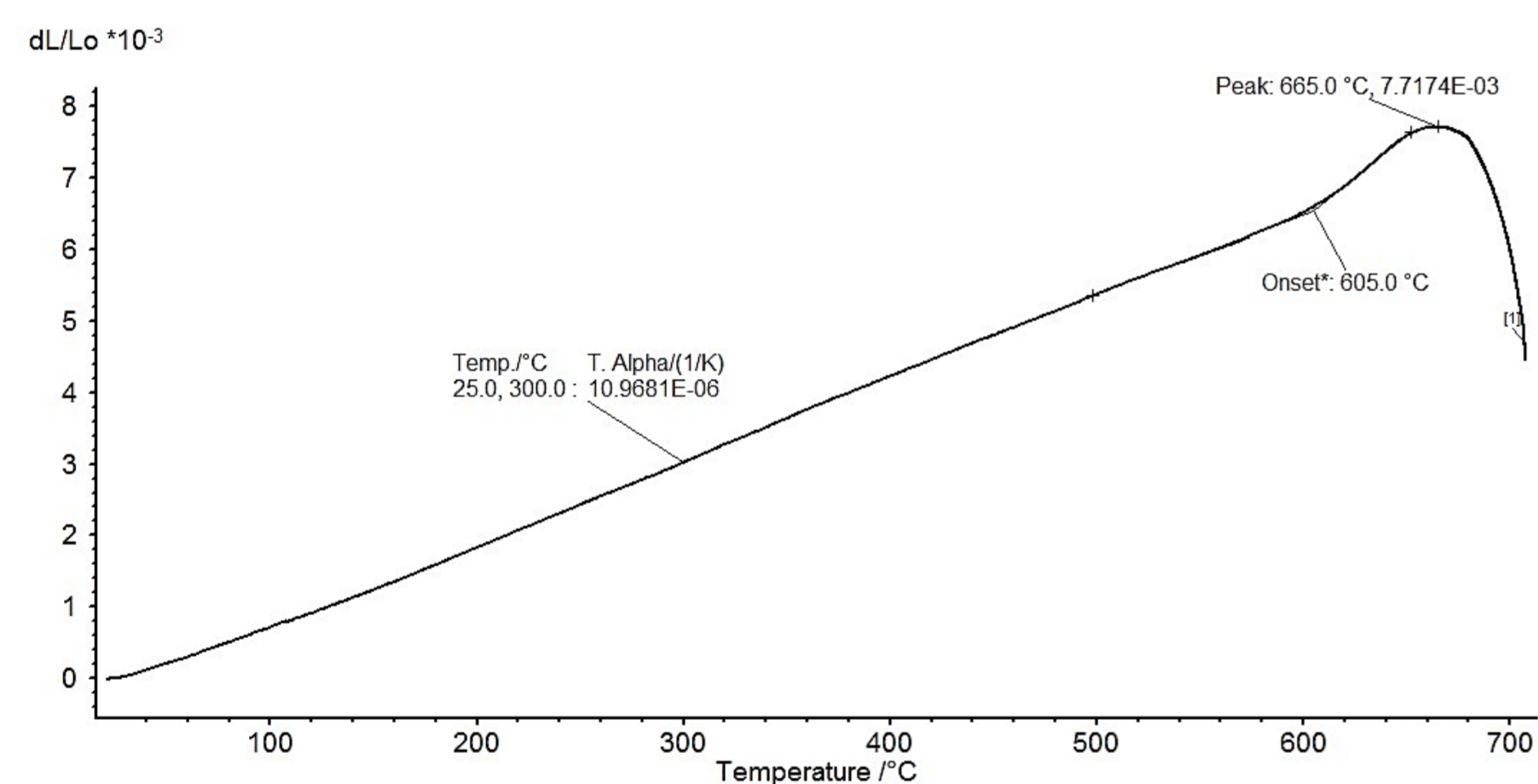
**In the Glass field**, the study reports the conservation issues concerning painting materials used in stained glass windows and their relation with the raw materials, the glass composition and the surrounding environment. These studies will lead us to a better understanding of the ageing and degradation mechanisms of glass and the best conservation methods.

Technical Art History, based on old recipes found in treatises, is a valuable tool to apply to the study of the productions techniques used in the making of glass paints. In Eraclius treatise “De Coloribus et artibus Romanorum” dated from the 10<sup>th</sup> century and translated by Mrs. Mary P. Merrifield in 1848, for example, we may read:

**XLIX. [272] How to paint upon glass.** *I must tell you to paint upon glass. Take a grossinum of sapphire, and the scales which are beaten of red- hot iron upon the blacksmith's anvil; and you must put one-third part of this with the grossinum, and mix it with lead glass, that is, Jewish glass, and grind it well on an iron slab and so you will be able to paint.*



Some of these old recipes, referred above, are being applied on colorless glasses reproduced in VICARTE, based on 14<sup>th</sup>, 16<sup>th</sup> and 19<sup>th</sup> century glass compositions from stained glass panels of the collection of King Ferdinand II. The objective is to study the compatibility of the glass substrate with grisaille paint layers, using thermal analyses, such as dilatometry and differential scanning calorimetry (DSC), in order to understand the thermal properties of these two materials.



Curve of thermal expansion from the reproduced colorless glass, Agnes von Wittelsbach.

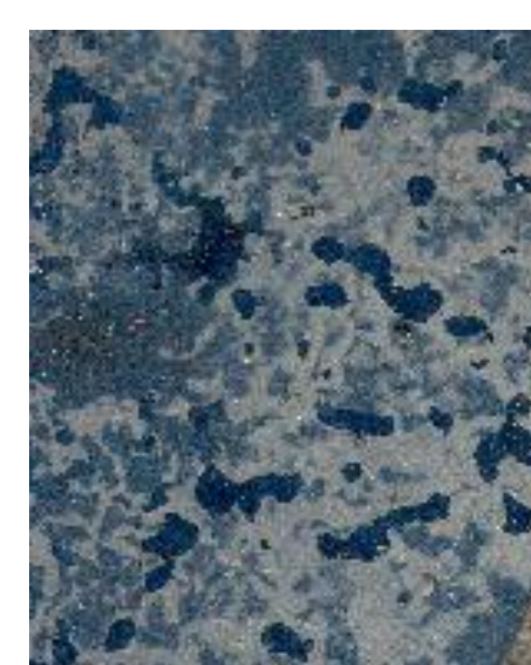


Historical stained glass windows, Agnes von Wittelsbach, PNP 2784.

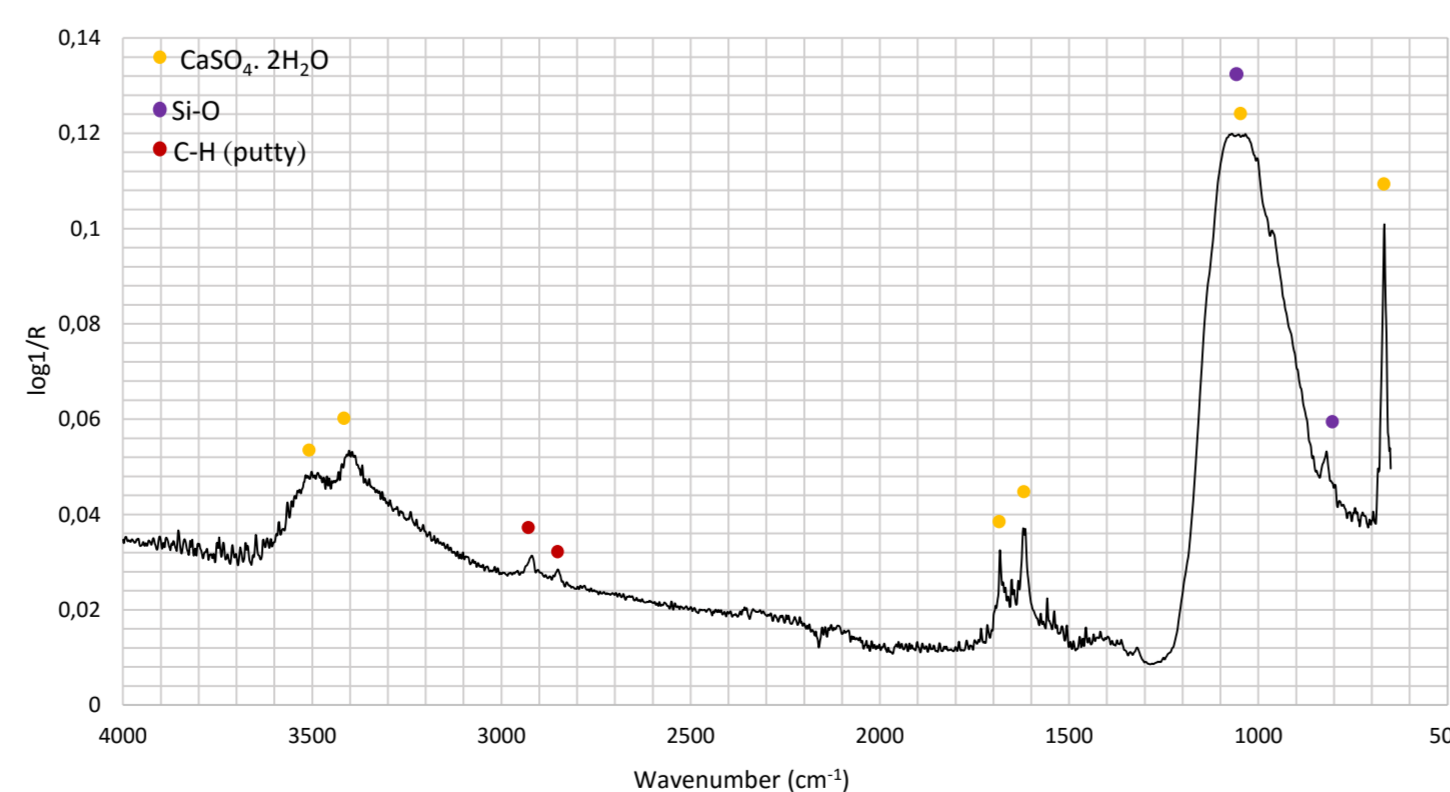
Stained glass panels from Palácio Nacional da Ajuda dated from the 19<sup>th</sup> are being analyzed in order to understand the degradation of the cobalt blue enamel, with the formation of *gypsum* ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) crusts, both in the surface and on the interface glass/enamel. This is very recurrent degradation problem, so new cleaning materials such as ionic liquids are being studied to restore the stained glass/enamel transparency.



Rondel from Palácio Nacional da Ajuda (PNA 3599).



White corrosion crust covering the blue enamel.



FTIR spectrum of  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  obtained from white crust.

**In the Ceramics field**, a study concerning the materials used in the conservation of archaeological ceramics is under progress. The aim of this investigation is to make a survey, characterization and evaluation of adhesives and filling materials used in Portuguese museums, from the 1970s up to the present. Four institutions were chosen and all the treatment records have been surveyed in order to establish a chronology of the materials and techniques applied over time.

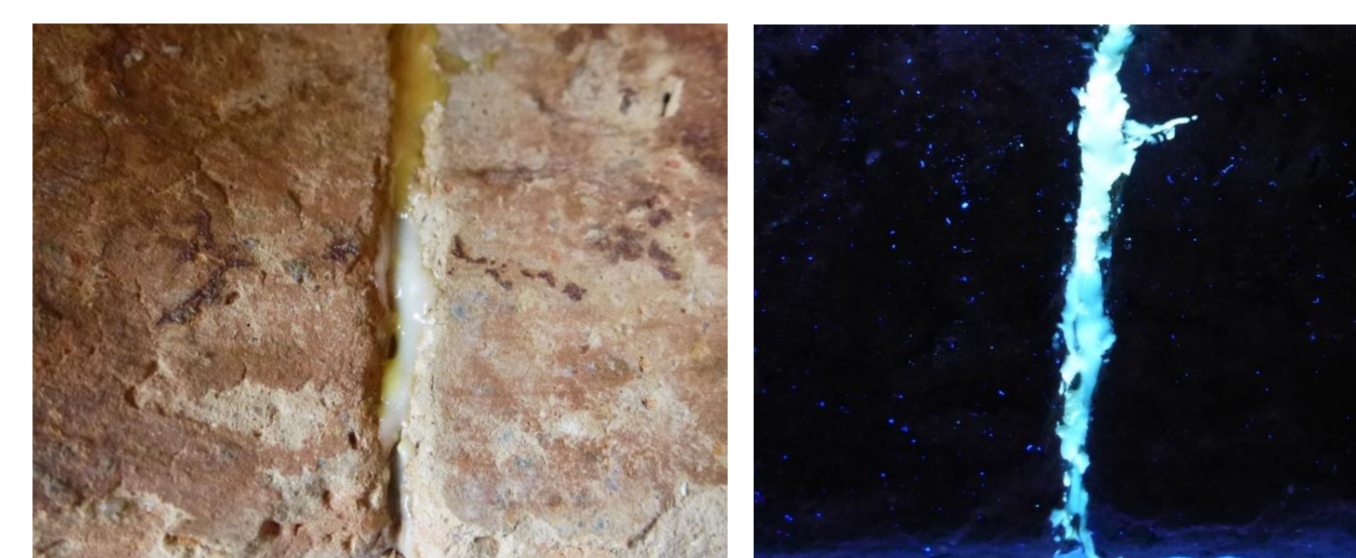
The adhesives used in those institutions in the course of the last 45 years can be grouped into two main types - acrylics and epoxy, although other types of adhesives were found in few objects.

Main adhesives mentioned in treatment reports, according with the period of use.

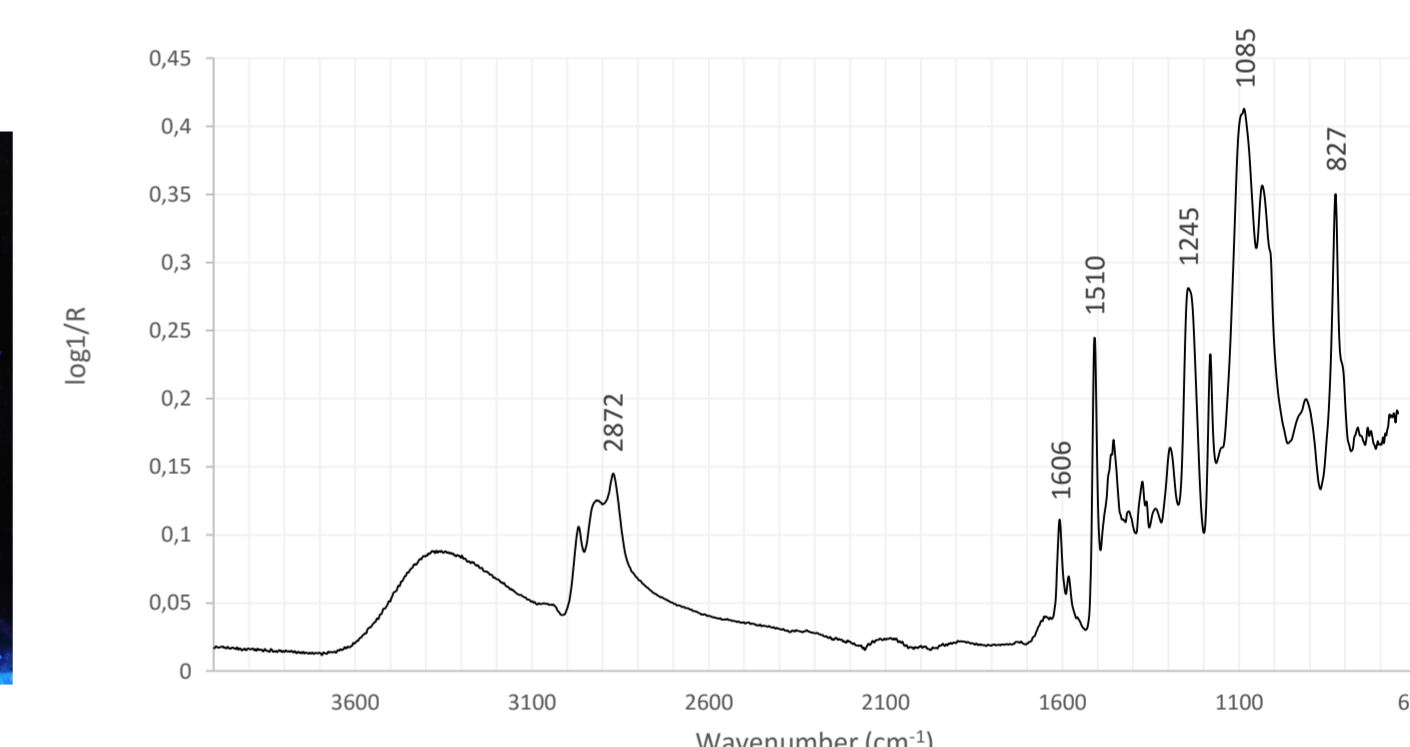
ADHESIVES						
Type	Name	1970	1980	1990	2000	2015
Acrylics	Plextol D540®		X	X		
	Plexigum N80®		X	X	X	
	Paraloid B-72®			X	X	X
	Paraloid B-44®				X	X
Epoxy	Devcon 5 minute®	X	X	X	X	X
	Araldite rapid	X	X			
	Araldite AY103®	X	X			
	Other*	X	X			
Other	Poly(vinyl acetate)*, contact adhesives*, cellulose nitrate**	X	X	X		

\* Brand not specified.

\*\* UHU Hart



Amphora fragments joined with an epoxy adhesive. Observation by natural light and UV light.

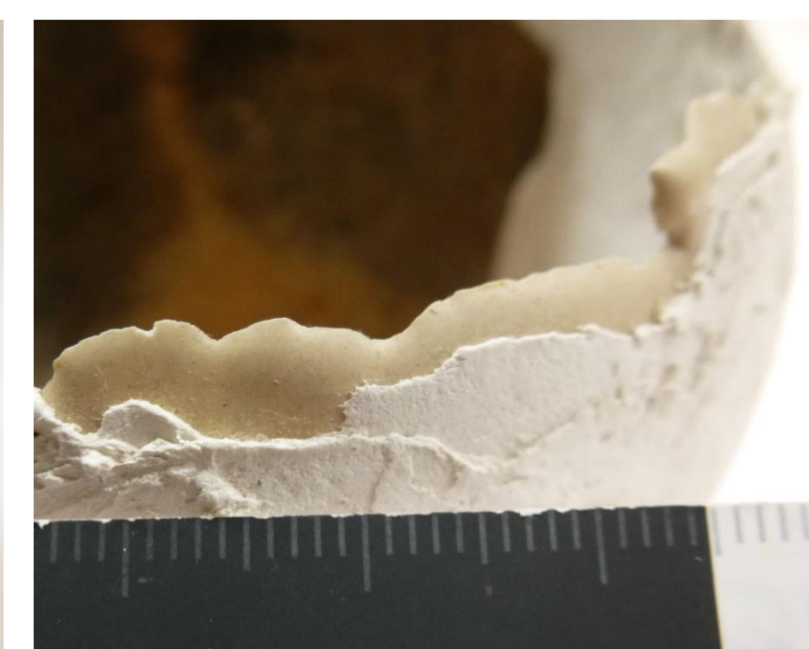


FTIR-ATR spectrum of epoxy adhesive Devcon 5 minute®.

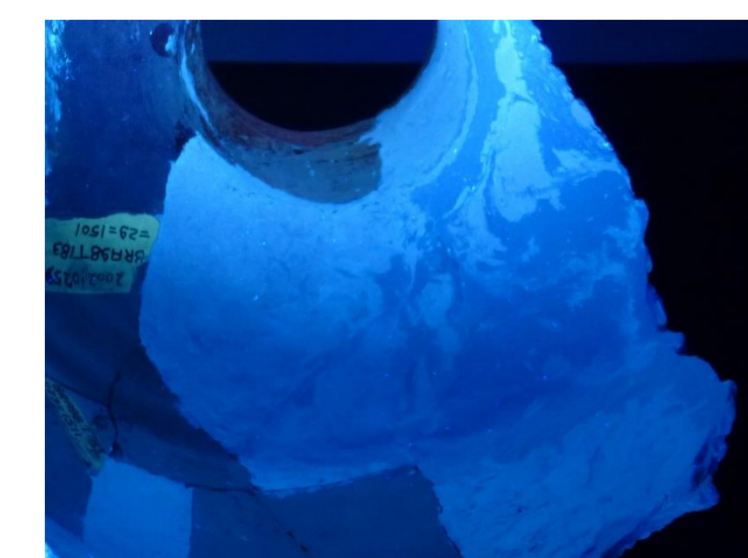
The types of filling materials did not change much along this timeframe and consist predominantly in polyester resins, calcium sulfate and modelling putties. The polyester resins were used pure or mixed with inorganic fillers or modelling putties. In some cases, these mixtures were used just in the making of an internal structure which was then covered with a finishing layer of a modelling putty. The calcium sulphate mostly used was dental plaster. Different brands of dental plasters were analyzed by FTIR-ATR and the results did not show significant differences in the spectra. The modelling putties are generally referred in the treatment reports without brand specification. However FTIR-ATR spectra showed that the different brands of analyzed putties have completely distinct compositions, which may be calcium carbonate or complex mixtures of calcium sulphate and silica as fillers, and a binder, for example.



Reconstruction of a pot, made with polyester resin and modelling putty on top.



Filling made with a mixture of polyester resin and modelling putty, clearly visible under UV light.



The evaluation of the materials condition, done by visual examination under natural and UV light, showed significant differences of color and physical properties on the epoxy, contact adhesives and cellulose nitrate adhesives. Data deriving from this study will be assembled in an database and made available to the conservation community.

### Conclusions

It is intended that the information resulting from these studies will act as a useful aid to the understanding of the relation between production techniques and damages, the choice of materials and will contribute to the study of the history of restoration techniques.