

# International Master Degree in Science for the Conservation - Restoration of Cultural Heritage

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<http://corsi.unibo.it/scienceforconservation/Pages/default.aspx>



# ORGANISATION OF THE CHEMISTRY DISCIPLINES

PHYSICAL CHEMISTRY

THE RULES

ORGANIC CHEMISTRY

CHEMISTRY

INORGANIC CHEMISTRY

THE MATTER

ANALYTICAL CHEMISTRY

DIAGNOSTIC  
METHODS



# ORGANISATION OF THE CHEMISTRY COURSE

ORGANIC CHEMISTRY

INORGANIC CHEMISTRY

## PHYSICAL CHEMISTRY

Chemistry for restoration: inorganic material

Advanced materials for cultural heritage

Air Pollution Chemistry

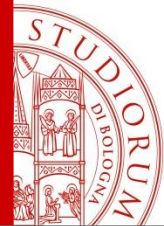
Chemical Methods of Examining Cultural Property

Analytical Chemistry of Organic Materials

Chemistry for restoration: organic material

Advanced materials for cultural heritage

## ANALYTICAL CHEMISTRY



# ORGANISATION OF CHEMISTRY COURSES

STUDY OF MATERIALS AND CONSERVATION METHODS

**Chemistry for restoration + LABORATORY**

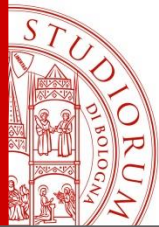
ENVIRONMENTAL CHEMISTRY APPLIED TO CULTURAL HERITAGE

**Air Pollution Chemistry**

ANALYTICAL CHEMISTRY APPLIED TO CULTURAL HERITAGE

**Analytical Chemistry of Organic Materials + LABORATORY :  
ANALYTICAL METHODS MAINLY FOR ORGANIC MATERIALS**

**Chemical Methods of Examining Cultural Property + LABORATORY :  
ADVANCED CHEMICAL NON DESTRUCTIVE AND MICRO  
DESTRUCTIVE METHODS**



# BASIC KNOWLEDGES TAKEN FOR GRANTED

## MAIN PRINCIPLES OF INORGANIC CHEMISTRY

- Atoms, molecules: chemical bonds and molecular interactions
- Stoichiometry
- Solubility and measure of concentrations
- pH
- Chemical reactions: precipitations, acid-base, redox

## MAIN PRINCIPLES OF ORGANIC CHEMISTRY

- Carbon to carbon single, double and triple bonds
- Aromatic compounds
- Functional groups
- Polymers
- Main natural polymers: proteins, polysaccharides

### Bibliography

- Chimica / Steven S. Zumdahl ; edizione italiana a cura di Dario Braga ... [et al.]. - 1. ed. italiana condotta sulla 2, Bologna : Zanichelli, 1993, or American version
- T W Graham Solomons, Craig B Fryhle, Chimica organica Trad. di V. Capriati, E. Florio, S. Florio, C. Galli, R. Luisi, G. Ortaggi, rev. di S. Florio, G. Ortaggi, ril., Zanichelli 2008 or American version
- Chemistry for restoration : painting and restoration materials / Mauro Matteini, Rocco Mazzeo, Arcangelo Moles, Firenze : Nardini, 2016
- The organic chemistry of museum objects / John S. Mills and Raymond White. Mills, John S., London ; Boston : Butterworth's, 1987.

# PRE-COURSE OF CHEMISTRY TO BE HELD IN SEPTEMBER!!!



# ADVANCED MATERIALS FOR CULTURAL HERITAGE

## The cleaning of polychrome surfaces



Lavinia Fontana- cleaning detail of  
Portrait of a Lady of the Court, 1590

### CLEANING PROCEDURE FOR THE REMOVAL OF:

- Superficial deposits (dust, smog,...)
- Oxidized and yellowish varnishes
- Previous restoration interventions

**Traditional method:** ORGANIC SOLVENTS



### PROBLEMS RELATED TO:

- Solvent retention
- Swelling
- Leaching
- Not selective removal



## How to clean New methods: Gels

### ADVANTAGES

- The solvents is confined into the gel so that leaching and swelling are reduced
- Hydrogel allows to host solvent with different polarity to remove different kinds of system
- Organogels have been also recently proposed for water sensitive substrates

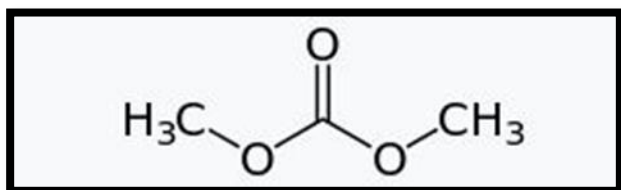
### DISADVANTAGES

- Gels residues may remains on the surface and should be removed using solvents

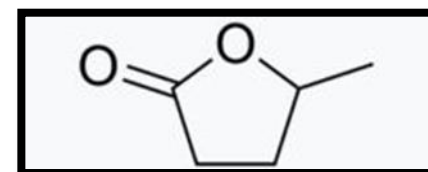




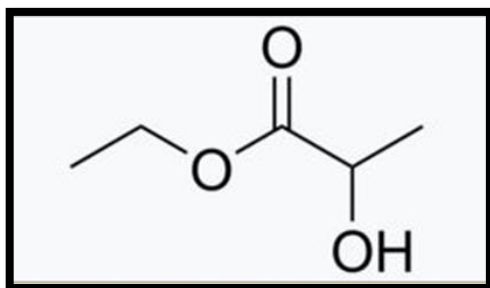
## Synthesis of the green gels



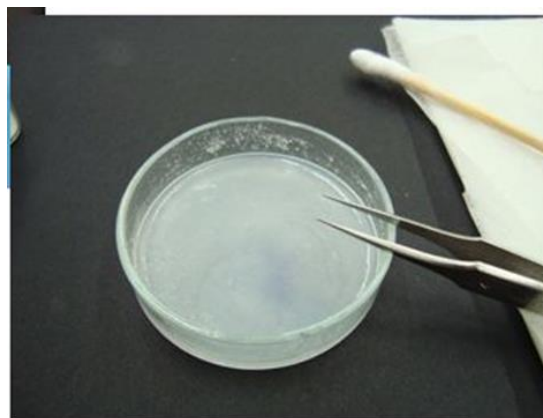
**Dimethyl carbonate**



**Gamma Valerolactone**



**Ethyl lactate**



**Biodiesel**

- Prati, S., Volpi, F., Fontana, R., Galletti, P., Giorgini, L., Mazzeo, R., Mazzocchetti, L., Samorì, C., Scitutto, G., Tagliavini, E. Sustainability in art conservation: A novel bio-based organogel for the cleaning of water sensitive works of art (2018) *Pure and Applied Chemistry*, 90 (2), pp. 239-251.
- Samorì, C., Galletti, P., Giorgini, L., Mazzeo, R., Mazzocchetti, L., Prati, S., ... Tagliavini, E. (2016). The Green Attitude in Art Conservation: Polyhydroxybutyrate-based Gels for the Cleaning of Oil Paintings. *ChemistrySelect*, 1(15), 4502-4508.
- Yiming, J., Scitutto, G., Prati, S., Catelli, E., Galeotti, M., Porcinai, S., Mazzocchetti, L., Samorì, C., Galletti, P., Giorgini, L., Tagliavini, E., Mazzeo, R. A new bio-based organogel for the removal of wax coating from indoor bronze surfaces (2019) *Heritage Science*, 7 (1), art. no. 34,
- Prati, S., Scitutto, G., Volpi, F., Rehorn, C., Vurro, R., Blümich, B., Mazzocchetti, L., Giorgini, L., Samorì, C., Galletti, P., Tagliavini, E., Mazzeo, R. 6; Cleaning oil paintings: NMR relaxometry and SPME to evaluate the effects of green solvents and innovative green gels (2019) *New Journal of Chemistry*, 43 (21), pp. 8229-8238



# ADVANCED MATERIALS FOR CULTURAL HERITAGE



The Majesty” attributed to Cimabue (XIII century)

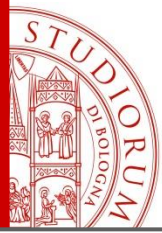


Male portrait from unknown Dutch painter (XIX century)



Pulpit by Donatello, Basilica di San Lorenzo, Firenze

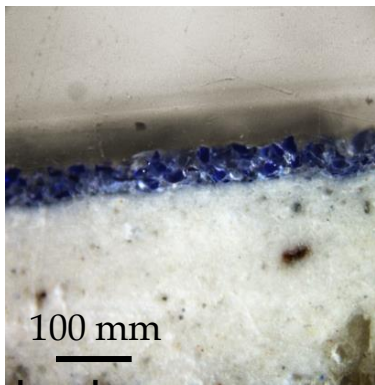
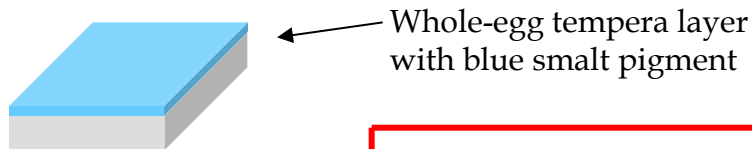
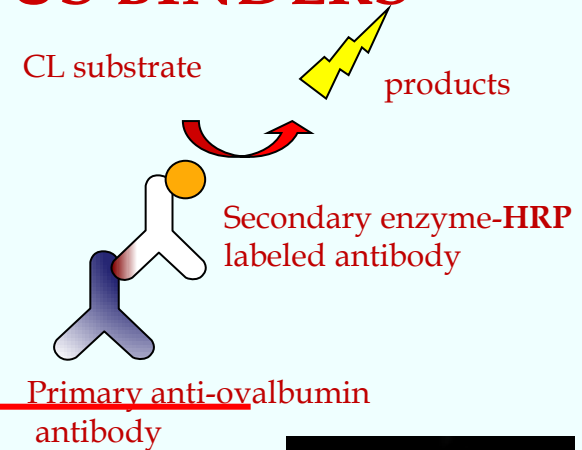
## Real case studies



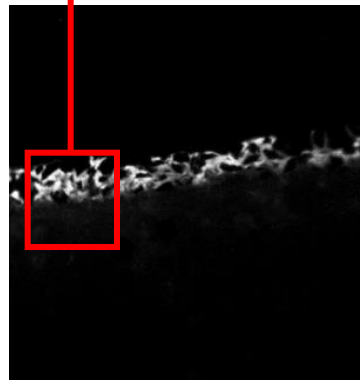
# CHEMICAL METHODS OF EXAMINING CULTURAL PROPERTY

## IMMUNO BASED METHODS FOR THE SELECTIVE LOCATION OF PROTEINACEOUS BINDERS

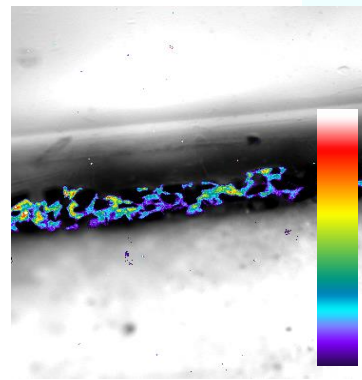
Measures performed on model samples with a layer of whole-egg tempera showed a CL signal in the correspondence of the tempera layer.



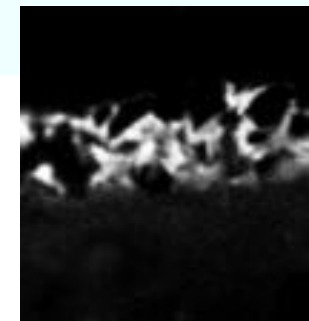
*Cross-section microphotography (10X objective)*



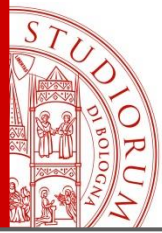
*Chemiluminescence image*



*Overlay of reflected light image and false color CL image*



As expected, the signal is localized only in the correspondence of the binding medium.

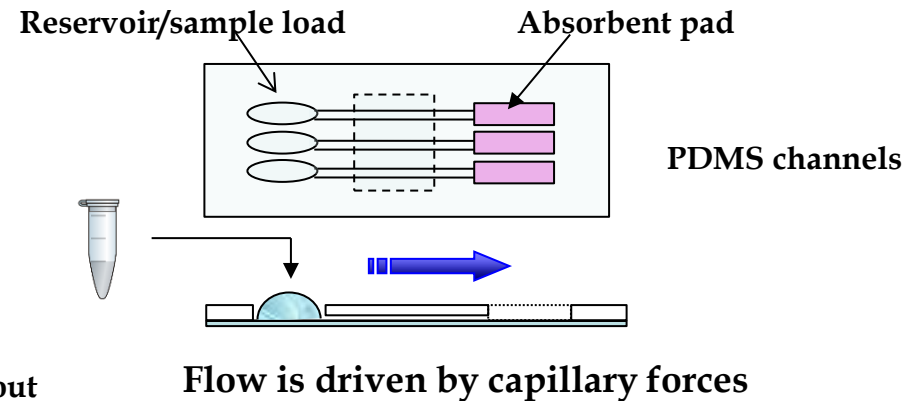
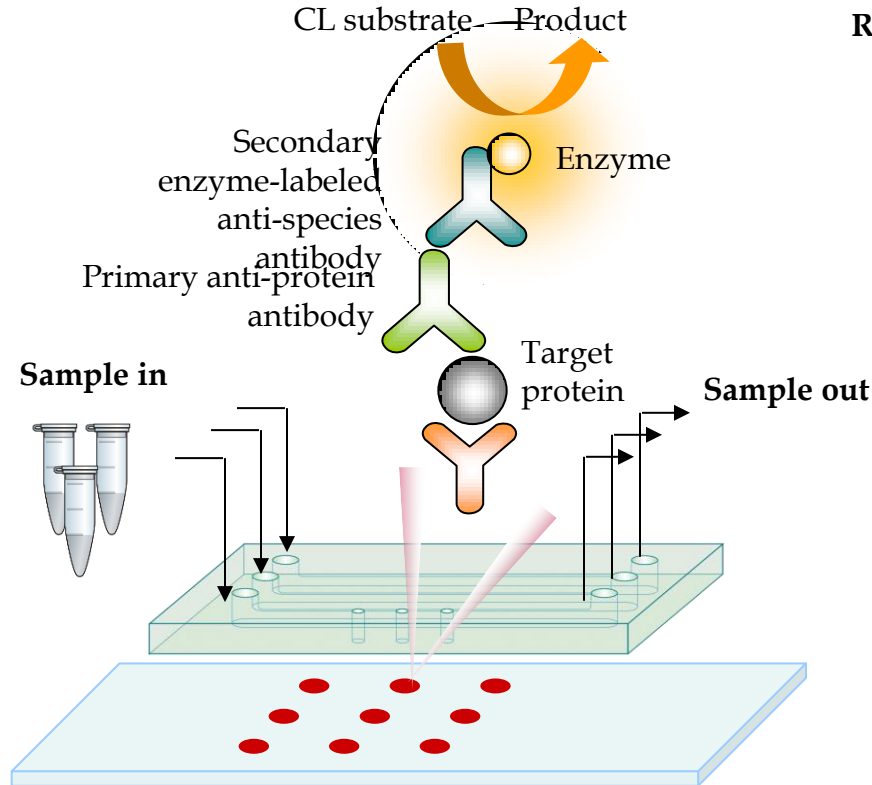


# CHEMICAL METHODS OF EXAMINING CULTURAL PROPERTY

## PORTABLE DEVICE

### Assay principle and procedure

*Ovalbumin* (from egg white) has been selected as protein target due to its frequent use in paintings as binders.



**Time for analysis:  
30 min**