

PAPERCON WORKSHOP, November 6, 2014

Developing Non-conventional Materials and Plasma Technique for Sustainable Solutions in Paper Heritage Conservation

Papercon

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Why Paper Heritage Conservation?

70-85% of items in libraries are prone to rapid degradation and are likely not to survive and remain readable in the 22nd century

Books of the 19th Century



(S. Buchanan and S. Coleman, *College and Research Libraries*, 1987, **48**, 102-147)

Limits in Paper Conservation

Current solutions

Old paper document

Decontamination

Deacidification

Consolidation

Restored paper document

Physical, biological and chemical control

Drawbacks and limitations

Toxic chemicals

Physical treatments

- Chemical interactions
- No long lasting effect

Cellulose ethers

- Hydrophilic films, susceptible to chemical and biological actions

Synthetic polymers

- Structural changes
- No reversible treatments

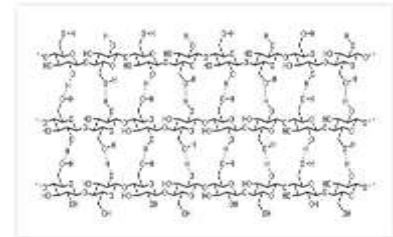
Challenges in Paper Conservation

Scientific and interdisciplinary approach by:

- ✓ **Having in view all materials** and their interactions with the environment
- ✓ **Understanding the degradation pathways**, which reveals adequate materials and techniques to be used
- ✓ **Applying the principle of reversibility** because better technique or materials may appear in the future



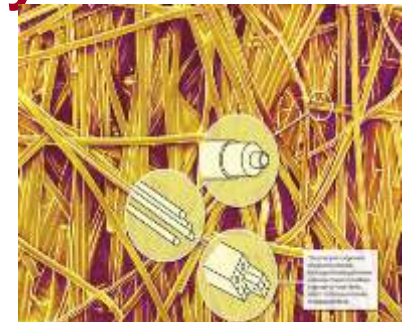
Paper and inks



Hydrogen bonding is the basis of paper structure

Monitoring and sustainability assessment by:

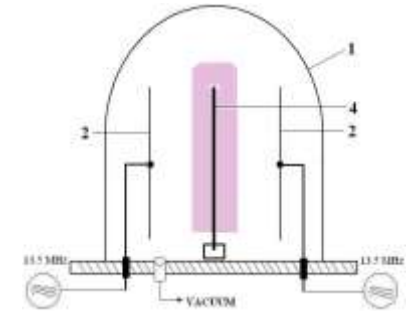
- ✓ **Implementation of non-destructive tools for quality control**, considering transfer of other fields
- ✓ **Standardisation of the methods for artificial aging**, which allow the assessment of conservation durability
- ✓ **Including protocols for adaptive management**



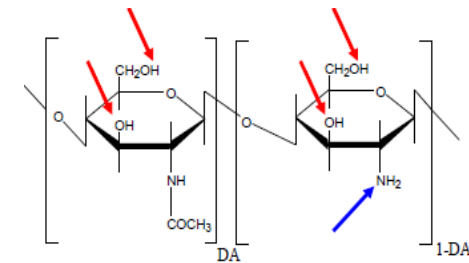
Spectroscopy

PAPHERCON Concept

● The innovation and application of cold HF plasma as a fast, soft and ecological treatment for the cleaning and microbial decontamination of paper heritage items



● The synthesis and application of chitosan derivatives with multiple functionalities in paper conservation - structure consolidation, barrier to water and antimicrobial activity



The development of innovative conservation method by combining the cold HF plasma treatments and multi-functional coatings based on chitosan derivatives

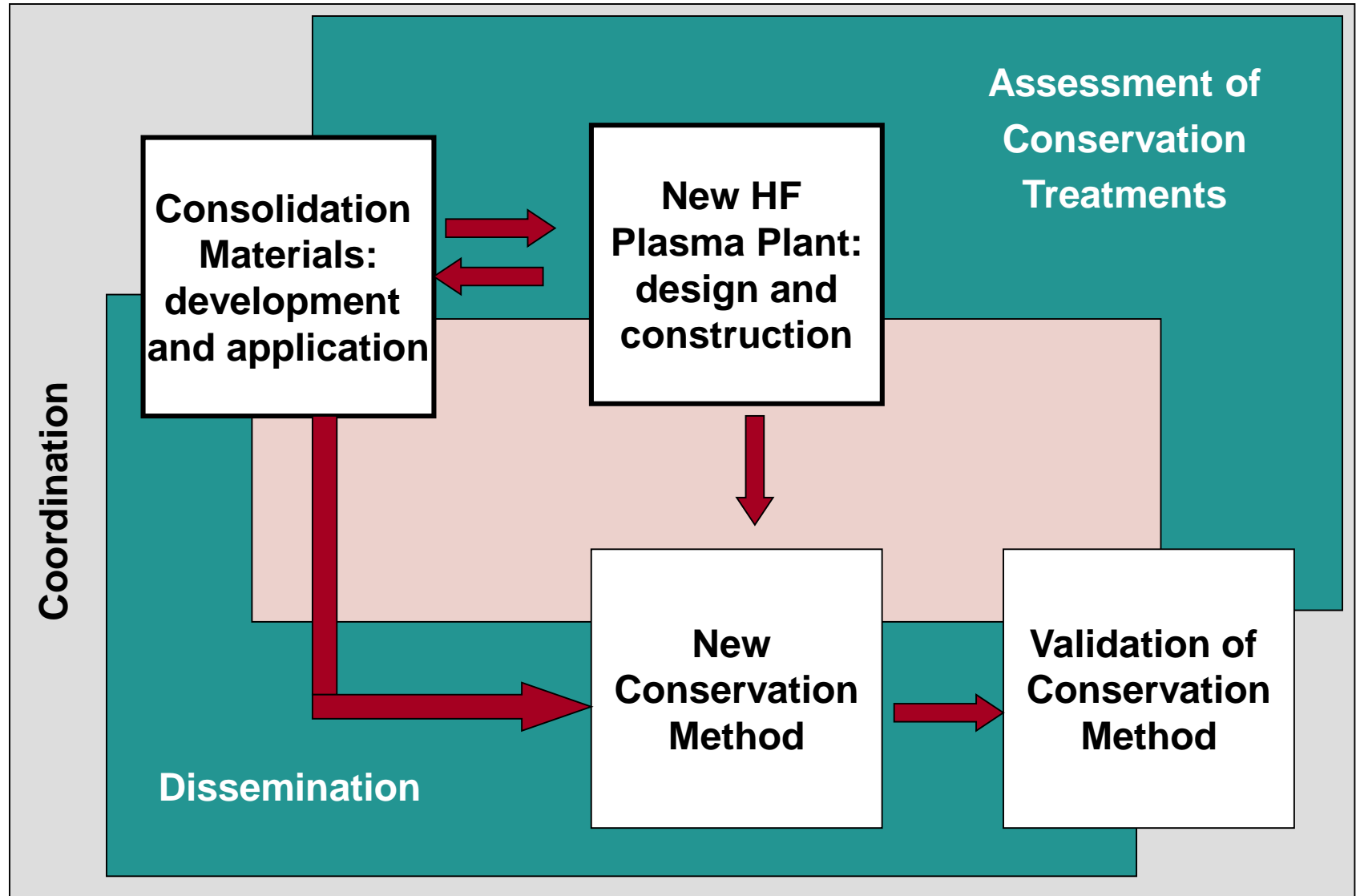
PAPHERCON Objectives

General objective: To develop, implement and validate a sustainable solution for conservation of paper heritage objects

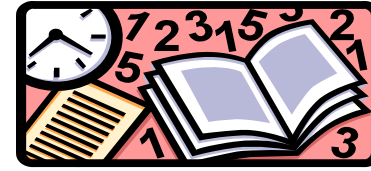
Specific objectives:

- **To improve the sustainability of paper conservation by:**
 - developing **bio-based materials and plasma technique** with multiple functions in conservation
 - a consistent **increase of conservation yield**, which will reduce the losses of the cultural paper heritage
 - achieving a more **friendly working environment** for conservators
- **To elaborate a reliable procedure for the evaluation** of conservation treatments, based on scientific approach
- **To gain consistent knowledge** in the field of the multifunctional biopolymers and on plasma techniques, which could be transferred to other organic materials (leather, wood, textiles)

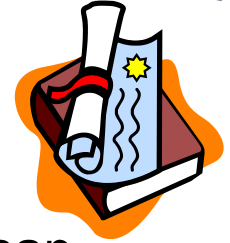
Project Structure



Project Phases



- 1. Research documentation and planning:** critical analysis of the materials, techniques and evaluation methods, currently used for the restoration and conservation of cultural paper heritage
- 2. New materials and techniques:** Nano-composites based on chitosan derivatives and cold HF plasma technique for the conservation of paper heritage objects
- 3. New conservation strategies:** Combining the cold HF plasma treatments and multifunctional coatings based on chitosan derivatives in sustainable solutions for paper heritage conservation
- 4. New and sustainable conservation method:** Definition and evaluation of new conservation method under real conditions, on natural aged paper documents



Achievements - Phase 1 (2012)

- ☺ **Experimental procedure** for testing the HF plasma and chitosan derivatives in paper conservation:
 - Model paper
 - Natural aged paper
- ☺ **Research protocol - step by step**
- ☺ **Set up the methods and techniques** to be applied in the evaluation of the materials and conservation treatments:
 - Physical - chemical properties
 - Physical – mechanical properties
 - Biological properties
- ☺ **Website structure development** (www.paphercon.ro)
- ☺ **Scientific communications:**
 - International events – 4
 - National events - 3

Achievements - Phase 2 (2013)

- **The development of multi-functional chitosan derivatives:**

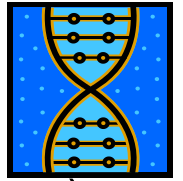
- Reproducible methods for the synthesis and characterisation of multifunctional chitosan derivatives.
- Interactions between chitosan derivatives and model paper sample

- **The effects of cold HF plasma treatments on paper properties**

- Optimisation of plasma parameters, based on **full decontamination vs. minimum impact on paper properties**
- The design of new cold HF plasma plant with extended functionality

- **Dissemination activities:**

- Webpage maintenance and development
- Scientific communications at international events - 5
- Publications in ISI journals - 2
- Publications in national journals (CNCSIS) - 1



Achievements - Phase 3 (2014)

- **Nano-composite coating formulas** (model paper and aged paper)
 - Chitosan derivatives + AKD (alkyldimercetene emulsion)
 - Chitosan derivatives + MFC (microfibrillated cellulose), with or w/o AKD
- **Combining plasma treatment with nano-coatings** (model paper)
 - Effects on paper properties - strength, barriers to water and microbes
 - Durability of conservation treatments, assessed by thermal aging
- **New cold HF plasma plant**
 - Construction and functional optimization
 - Decontamination tests (natural aged paper)
 - Effects on paper properties before and after coating (model paper)
 - **Dissemination activities:**
 - Webpage maintenance and development
 - Communications to Paphercon Workshop + other – 8 + 5
 - Publications in ISI journals – 2 + ?
 - Patent proposals - 2

Project Partners



„Gheorghe Asachi” Technical University of Iasi, **TUIasi**



"Petru Poni" Institute of Macromolecular Chemistry Iasi, **ICMPP**



“Alexandru Ioan Cuza” University of Iasi, **UAIC**



"Moldova" National Museum Complex of Iasi, **CMNM**



SC IMPEX ROMCATEL SA, **ROMCATEL**



Thank you
for your attention!

Project information

Acronym: **PAPHERCON**

Research program: **PN-II-PT-PCCA-2011**

Duration: **23.07.2012 – 23.07.2016**

Website: www.paphercon.ro

Contact person

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