

## Raman, chromatography and microscopy studies for wax-sealed documents from some old Romanian pulp and paper factories

Rodica-Mariana Ion<sup>1,2\*</sup>, Adrian Radu<sup>1</sup>, Sofia Teodorescu<sup>3</sup>, Alin Bucurică<sup>3</sup>, Raluca-Maria Știrbescu<sup>3</sup>, Nicolae-Mihail Știrbescu<sup>3</sup>, Maria Geba<sup>4</sup>

<sup>1</sup>*The National Institute for Research & Development in Chemistry and Petrochemistry – ICECHIM, 202 Splaiul Independenței, 060021-Bucharest, Romania*

<sup>2</sup>*Valahia University of Târgoviște, 13 Aleea Sinaia, Târgoviște, Romania*

<sup>3</sup>*Multidisciplinary Scientific and Technologic Research Institute, Valahia University of Târgoviște, 13 Aleea Sinaia, Târgoviște, Romania*

<sup>4</sup>*“Moldova” National Complex of Museums, Piața Ștefan cel Mare și Sfânt 1, Iasi, Romania*

\*[rodica\\_ion2000@yahoo.co.uk](mailto:rodica_ion2000@yahoo.co.uk)

Waxes have been used as adhesives, as painting media, for surface coating purposes, as a component of seals and as a modelling or casting materials and also in conservation practice. The history of detection and identification of waxes can be connected to modern methods of analysis [1]. Waxes are translucent solid substances with mineral, vegetable and animal origin, easy to solubilize. They contain long chain hydrocarbons, acids, alcohols and esters or mixtures of these. Some types of wax components are fully saturated materials with a considerable chemical stability and waterproofing properties.

Most damages in library and archive collections are of mechanic character: cracks, missing pieces or pollution and excessive handling of documents. With wax seals, the loss of fatty acids and non-permanent alcohols causes saponification, so the material becomes both opaque and friable. In this paper the compositional analyses have been achieved by Raman spectroscopy and Fourier transform infrared spectroscopy (FTIR), which can provide molecular structural information of wax materials. Also, the composition of degraded wax seals was determined using gas chromatography / mass spectrometry (GC/MS), for evidence of some alkenes with 31, 32, 33 and 35 carbon atoms. The gas chromatography has been used in the detection and identification of small amounts of waxes and greases encountered in old paper conservation. The aspect of degraded wax seals and paper substrates have been identified and discussed by optical microscopy and scanning electron microscopy. All these analytical investigations have been achieved for paper samples from two disaffected pulp and paper factories - Letea and Bușteni (Romania) belonging to industrial patrimony, proving the damaging effect of wax seal for paper documents, in order to optimize the proper solutions for conservation and restoration.

This paper has been prepared with the financial support of the PNII 261/2014, PNII 222/2012 and PN 16.31.02.04

[1] R.M. Ion, R.C. Fierăscu, I. Fierăscu, M.L. Ion, S. Teodorescu, M. Geba, Spectral and microscopic characterization of manuscripts with wax seal, Proc. ARSA, (2015), pp. 178-182