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Damage Ranking in Historical Parchment: From Microscopic Study of Fibres Shrinkage to Collagen Denaturation Assessment by micro-DSC

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Damage Ranking in Historical Parchment: From Microscopic Study of Fibres Shrinkage to Collagen Denaturation Assessment by micro-DSC

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Heritage institutions throughout Europe house significant collections of parchment objects that preserve the almost entire written heritage from the classical age to Renaissance. It is thus of high importance to understand their conservation conditions in order to design the most appropriate strategies for preservation, display and storage. Historic parchment is a complex biological material whose investigation represents an analytical challenge due to the number of variables (i.e. methods of production, unknown environmental histories of objects, heterogeneous nature of animal skin, etc.) influencing the deterioration patterns. Such patterns can only be revealed by surveying the properties of a significant number of objects. In this lecture the outcomes of a study including more than 100 artificially aged parchments and more than 200 historical parchments (documents, rolls, bookbindings) are presented with a focus on micro-destructive methods as Micro Hot Table (MHT) method, and micro Differential Scanning Calorimetry (micro DSC). Since damage to collagen within historical parchment can be variously distributed throughout its hierarchical organisation, the employment of both these methods offers the advantage to provide complementary information on specific alterations at fibre and fibril levels and prevent partial evaluations. The procedures for early detection of damage and its characterisation and quantification were developed within the EC project *Improved Damage Assessment of Parchment* (IDAP, EVK4-CT-2001-00061) and have then been applied in the projects OPERA,¹ MuSA-System², and COLLAGE³.

The microscopic assessment by MHT method could be easily used by conservators and the knowledge gained so far allows for a partly quantitative assessment of deterioration at the fibre level and ranking of parchments in four damage categories, from not damaged to severely damaged. On the other hand, micro DSC is a valuable tool for research purposes as it unambiguously quantifies the damage severity, evaluates thermal and structural stability of collagen populations and discriminates between stable and unstable parchments. When possible (micro-sampling allowed, equipment and expertise available), micro DSC can highly support conservation decisions that strongly depends on the stability of collagen populations in historical parchments.

¹ Old Parchment: Evaluation, Restoration and Analysis, Piedmont Region project CIPE 2004 D39 (2006-2010).
<http://www.opera-parchment.it/>

² Study and Diagnosis of Historical Parchments Using Improved Systems for Multispectral Analysis, Joint project between the University of Turin and the National Institute of Metrological Research (INRiM). The project is funded by the Compagnia di San Paolo of Turin., Italy (2011-2012).

³ Intelligent System for Analysis and Diagnosis of Collagen-Based Artefacts, Joint Applied Research Projects PNII 224/2012, National Authority for Scientific Research (ANCS), Romania (2012-2015).

Elena Badea, Senior Lecturer at the University of Craiova, Romania

Elena Badea graduated with a PhD thesis in Chemical Engineering in 2001 from the University “Dunărea de Jos” of Galați, Romania. In 2001, she became Lecturer in Biochemistry at the Faculty of Sciences, University of Craiova, Romania. In 2000, she was awarded a NATO Outreach fellowship from the Italian National Research Council (CNR). In 2001 – 2003, Dr Badea spent several study periods on isothermal microcalorimetry and micro DSC at the University of Trieste, University of Milan, Birkbeck College, University of London, and University of Greenwich. The participation of Dr Elena Badea in a number of research projects at the University of Turin was made possible by the “General Accord for Cooperation and Scholar Exchange in Chemistry and Physics” between the University of Craiova and the University of Turin.

Dr Badea’s research involves, amongst other projects, the use of micro DSC, thermal microscopy and SEM for the study of heritage collagen-based materials and collections, and their interactions with the environment. Presently Dr. Badea is coordinating the Romanian ANCS research project *Intelligent System for Analysis and Diagnosis of Collagen-Based Artefacts* (COLLAGE) aiming at the development of a new integrated (software and hardware) commercial system for the automatic detection of collagen shrinkage activity. She is also involved, as a researcher under contract, in the joint project of the University of Turin and the National Institute of Metrologic Research, Turin, *Study and Diagnosis of Historical Parchments Using Improved Systems for Multispectral Analysis* (MuSA-System) whose objective is to prototype an easy-to-use and cost-effective multispectral scanning procedure allowing both document analysis (diagnostic and monitoring) and exploitation (digitalisation, access, storing).

She was co-organiser of the International Seminar and Workshop *Conservation and Restoration of Parchments*, Turin, 5-8 September 2008, scientific chair of the 1st and 2nd *International Conference Matter and Materials in/for Heritage Conservation*, Craiova, 15-18 September 2009 and 24-28 August 2011 and co-chair of the 1st *International Seminar and Workshop Preservation of Parchment, Leather and Textiles*, Bucharest, 24-26 September 2012.

Giuseppe Della Gatta, Professor emeritus of Physical Chemistry at the University of Turin, Italy

Since 1992 Della Gatta has become interested in the advanced physical-chemical investigation of cultural heritage especially by calorimetry and thermal analysis, and has promoted and organised seminars, workshops and symposia during the Congresses of the Italian Society of Calorimetry and Thermal Analysis (AICAT), of which he was the founder and the Italian Society of Chemistry (SCI), as well as during the ESTAC and MEDICTA Conferences. Since then all these conferences have had *Cultural Heritage* as stable topic.

Della Gatta was the Italian partner in the EU project *Improved Damage Assessment of Parchments* (IDAP) in 2002-2005 and coordinator of the Italian Project *Old Parchments Evaluating: Restoration and Analysis* (OPERA) in 2006-2009, on the assessment, monitoring and restoration of old parchments. He has also coordinated PhD theses and post-doctoral fellowships on Cultural Heritage. Since 2008 to the present he is guest researcher, Department of Chemistry, University of Turin and volunteer consultant, National Institute of Metrological Research of Turin. He is currently involved in the project *Study and Diagnosis of Historical Parchments Using Improved Systems for Multispectral Analysis* (MuSA-System).

Della Gatta is the author of more than 120 papers and editor or co-editor of 9 special issues of *Thermochimica Acta* and 3 special issues of *Pure and Applied Chemistry*, and has given more than 60 plenary and invited lectures at international conferences, symposia, schools, etc.

Membership of the Editorial and Advisory Boards of International Journals: *Thermochimica Acta*, Elsevier (1989-2003), *Journal of Chemical Thermodynamics*, Elsevier (1990-1997; 2000-2009), *Journal of Thermal Analysis and Calorimetry*, Kluwer-Springer (2004-2006).

Awards: Honorary Medal “N.S. Kurnakov”, Russian Academy of Sciences (1990); Honorary Medal 50th Anniversary of University of Łódź, Poland (1998); Mettler-Toledo Award delivered by the North American Thermal Analysis Society (2003); Gold Medal of the Italian Society of Chemistry (2007).