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Ars et Scientia: *Analytical Chemistry for Cultural Heritage*. A Book Review

Ars et Scientia: *Analytical Chemistry for Cultural Heritage* (Química Analítica para Patrimonio Cultural). Una reseña de libro

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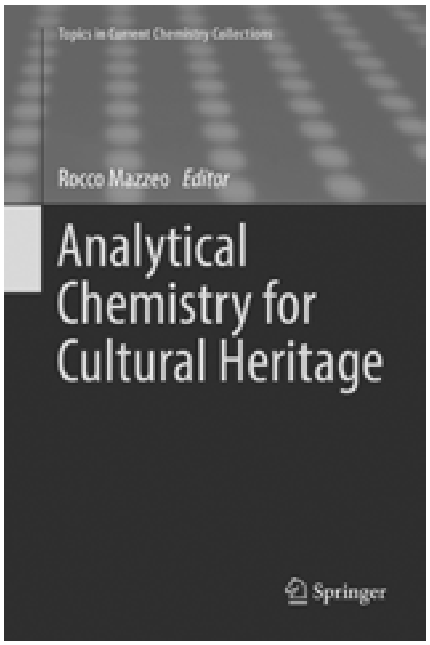

FIGURE 1. Cover of *Analytical Chemistry for Cultural Heritage*, Topics in Current Chemistry Collections, Berlin, Springer, 2017, ISBN: 978-3-319-52802-1, 978-3-319-52804-5 (eBook) (Courtesy: Springer, 2016).

Abstract

Review of the book *Analytical Chemistry for Cultural Heritage* (2017) that compiles eleven articles reporting the new advances of analytical techniques applied to Cultural Heritage in fields such as Science for the Conservation and Archaeometry. Each article offers a general view of the technique and the newest advances of the recent years, exemplified by research projects from around Europe.

Keywords

analytical chemistry; cultural heritage; science for conservation; archaeometry

Resumen

Reseña del libro *Analytical Chemistry for Cultural Heritage* (*Química analítica para patrimonio cultural*, 2017), que compila un total de 11 artículos donde se presentan los nuevos avances en técnicas de análisis aplicadas a estudios del patrimonio cultural en ámbitos como la ciencia y la arqueometría. Cada artículo presenta una visión general de cada especialidad y de los avances más significativos de los años recientes, ejemplificados con experiencias de investigación en Europa.

Palabras clave

química analítica; patrimonio cultural; ciencia aplicada a la conservación; arqueometría

During the last decades, multiple venues of interdisciplinary research within the cultural heritage field have been a subject of academic discussion. From the interaction of conservation with Art History, to the utility of merging archaeology with analytical techniques, these intersections have generated and developed new specialization areas, such as Conservation Science (Heritage & Golfomitsou 2015), Technical Art History and, Archaeometry (Hermens 2012). In recent publications, scientists and conservators have also underscored the importance of art history as well as the fundamental role of the natural sciences in the conservation of cultural heritage (Artioli 2010:2-3; Siano 2012).

Physics and chemistry, specifically analytical chemistry, have greatly contributed to the maturity of cultural heritage conservation as a field of enquiry in its own right. On the one hand, these hard sciences have derived into the shaping of modern techniques for the study of objects, including many new non-invasive methodologies (Gomez-Sepulveda *et al*. 2017). On the other hand, science has provided strong foundations for the development and evaluation of conservation treatments, as the modern "green" gel systems for cleaning (Carretti *et al*. 2009). Therefore, newer areas of specialization —namely conservation science and archaeometry— have become an integral part of cultural heritage conservation. In this context, it is worth of attention that the editorial house Springer has summarized some of the most recent publications on scientific cultural heritage research in the book *Analytical Chemistry for Cultural Heritage* (2017) —edited by Rocco Mazzeo from the department of Chemistry at the Università di Bologna— as part of the series Topics in Current Chemistry Collections.

The book contains eleven articles that present the latest research and advances in analytical chemistry applied to both cultural heritage conservation science and archaeometry. It includes investigations in the field of spectroscopy, chromatography, immunochemistry and dating, which allow for the characterization of their materiality, their degradation and, in some cases, the provenance of their manufacture materials.

Heritage professionals have permanently debated over the manner in which new specialization fields are to be defined: for instance: the term "archaeometry" was born mainly related to the dating methods but etymologically it can be understood as the measurement of the past in terms of data, thus in some cases it also includes the conservation science (Siano 2012:13). In comparison, the establishment of conservation science or science for the conservation as a new field of specialization served to emphasize the importance of studying an artifact, including its complete diagnosis and the analysis of degradation mechanisms and, furthermore the evaluation and development of preservation treatments. Yet, many scientists (i.e. Artioli 2010; Siano 2012) still propose that archaeometry covers conservation science. In *Analytical Chemistry for Cultural Heritage* (2017), these two disciplines are merged together, since analytical chemistry offers useful tools applicable to each one. In fact, this book offers no definition of any of the above mentioned professional fields since its main focus is to show how new advances in applied analytical methods and techniques have impacted heritage studies in the last decades.

From spectroscopic techniques to dating methods, specialists from Italy, France, Germany, Belgium and U.S. present the most innovative projects concerning the study of cultural heritage. As the editor mentions (Mazzeo, R. 2017:vii-x), the publication is not a comprehensive collection of analytical chemistry techniques but rather aims to provide a synthetic overview of the different areas in which these scientific tools have been applied in order to solve some of the questions that conservators, art historians and archaeologists face during the approach of their objects of study.

As is the current trend in this field, the use of non-invasive and non-destructive techniques is exposed in two chapters (Brunetti *et al*. 2017:41-76; Janssens *et al*. 2017:77-128): this is clearly a sharp response to the high demand of methods that allow for the study of an object *in situ* and without the removal of material. Yet as the remaining nine chapters of the book confirm (Bertrand *et al*. 2017:1-40; Prati *et al*. 2016:129-160; Casadio *et al*. 2017:161-212; Sciutto *et al*. 2017: 213-240; Cartechini *et al*. 2017:241-262; Degano & La Nasa 2017:263-290; Bonaduce *et al*. 2017:291-328; Vai *et al*. 2017:329-346; Strydonck M. V. 2017:347-364), the process of sampling remains one of the most effective methods for studying complex matrices, such as stratigraphic conformation. Nevertheless, it is worth of attention that the amount of sample required to perform analysis has been reduced considerably due to increased efficiency and sensibility of new techniques and analytical equipment.

Following this argument, Brunetti *et al*. (2017:41-76) demonstrate that the main problem associated with non-invasive techniques is the matrix effect caused by multilayer systems, when recording data in backscattering, emission or reflection modes. Indeed, in these cases not only the rendering of data results increasingly complex, but analysis usually requires interpretation models obtained from known samples. In this sense, the experience of the MOLAB (MObile LABoratory), a project that aims to compare portable and transportable instrumentation available within a group of European institutions, is useful since it shows the capacity, drawbacks and advantages of several techniques, such as Fourier-Transform Infrared Spectroscopy (FTIR), X-Ray Fluorescence (XRF), external Data Representation (XDR) and Ultraviolet-Visible Spectrophotometry (UV-vis) (Brunetti *et al*. 2017:41-76).

As it is well known, spectroscopy is a technique based on the interaction of electromagnetic radiation with matter (Derrick *et al*. 1999:4). Synchrotron is one of the newest spectroscopic techniques to have an application in cultural heritage: Its polychromacity allows for the application of different kinds of techniques such as FTIR, X-ray fluorescence and UV photoluminescence (Bertrand *et al*. 2017:1-39). The advances in synchrotron application to cultural heritage have allowed for the morphological study of samples but also for its chemical analysis, both organic and inorganic, as well as imaging by tomography and XRF mapping. The latter is capable of revealing changes in the chemical composition of the objects, and the identification of traces, for instance organic residue in fossilized samples (Bertrand *et al*. 2017:1-39).

Prati *et al*. (2017:129-160) introduce new advances of FTIR analysis. FTIR is a common technique used for the study of organic components of cultural heritage materials: however, one of the main disadvantages is the interference and superposition of many bands, for instance the water interference (2017:129-160). Sample preparation optimization is an effective way to reduce the contamination of embedding materials in the case of thin layer and cross-section samples, allowing also the acquisition of hyperspectral imaging (2017:129-160). Additionally, the Surface Enhanced Infrared Reflection Absorption (SEIRA), is useful for the analysis of small amount of sample, in the order of microliters, obtaining high signal response.

Two of the articles (Sciutto *et al*. 2017:213-240; Cartechini *et al*. 2016:241-262) of this book relate the application of immunochemical methods for the identification of proteinaceous components. The coupling of these techniques with other systems such as Surface-Enhanced Raman Spectroscopy (SERS) has provided promising results for the identification of materials —mainly binders — in paint samples as reported by Sciutto *et al*. (2013:933) when studying paintings by Giuseppe Milani (1719-1798) and Baldassare Carrari (1460-1516). In addition, the use of microscopic imaging allows for the identification —both chemically and spatially in a multilayered sample— of proteinaceous components, for instance binders in paint samples, as is presented by Sciutto *et al*. (2017:213-240).

Two articles of this book feature the improvements of High Performance Liquid Chromatography (HPLC) and Gas Chromatography coupled with Mass spectrometry (GC-MS) for the study of organic components in artworks. On the one hand, Degano & La Nasa (2017:263-290) review the sample preparation and the systems recently applied to cultural heritage such as reverse chromatography and ion chromatography, not only for the identification of dyes and binders, as it has been commonly applied, but also for the study of degradation processes such as black crust formation due to environmental pollution. Whereas the performance of GC-MS in the last decades is described in the second article, not only for the characterization but also for the understanding of the degradation and the stability of materials, in archaeological, classical and contemporary art (Bonaduce *et al*. 2017:291-328).

The last two articles of *Analytical Chemistry for Cultural Heritage* focused on DNA analysis and Dating techniques. Vai *et al*. (2017:328-346) introduce an overview of the development of ancient DNA techniques, reporting their advances, for example, the capacity of recovering a complete genome from damaged samples. Strydonck (2017:347-364) state that dating techniques have improved by the introduction of Accelerator Mass Spectrometry, which has been used to analyze not only prehistoric remains, but also textiles and sculptures.

To sum up, *Analytical Chemistry for Cultural Heritage* is a publication that follows the current trend of technological improvement in order to obtain a better understanding of cultural heritage materials, their degradation, and the evaluation of conservation processes. It is the result of the work of several research groups throughout Europe, that are focusing their efforts on the development of techniques that better meet the needs of cultural heritage investigations.

In comparison with previous publications, such as *Analytical Chemistry in Archaeology* (Pollard *et al*. 2006), Springer's edition offers a comprehensive overview of the new advances in analytical techniques, adding information from the improvements done in the last decades by the different research groups that contributed to the publication of the present volume.

Other publications as *Scientific Methods and Cultural Heritage* (Artioli 2010) are not only focused on technical details but also on the very definition of the discipline. In this sense, *Analytical Chemistry for Cultural Heritage* represents a document that covers the newest advances in terms of techniques available for the study of cultural property, without ascribing a specific disciplinary field different from the Analytical Chemistry. Thus, its scope is to show the improvements in the analytical approaches that can be useful for researches around the world. The book accomplishes its objective by showing and overview of the advances and offering a rich bibliography.

As a whole, this book is useful both as brief introduction for the non-specialized reader, as well as students, for more in depth comprehension of analytical techniques, and provides an important bibliographical compilation. Meanwhile, for a specialist, it provides a summary of the most recent advances in the field, which may be useful for the implementation and improvement of analysis of cultural heritage.

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