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Raman Spectroscopy in Archaeology and Art History

edited by H.G.M. EDWARDS *and* J.M. CHALMERS

series editor NEIL W. BARNETT

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Raman Spectroscopy in Archaeology and Art History

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Preface

This book arose from the meeting on Raman Spectroscopy in Art and Archaeology in November 2001, at the British Museum, London, which was sponsored jointly by the Royal Society of Chemistry, Analytical Division, Molecular Spectroscopy Group and the British Museum. At this event, 120 delegates from 17 countries representing a wide range of scientific disciplines and museums met to evaluate the applications of Raman spectroscopic techniques for problem solving and analysis in conservation science, art restoration, art history and archaeology.

The contributions in this book are based largely on topics presented at the meeting and comprise 42 authors from 7 countries. An introduction and four applications sections, each containing an overview and several case studies, are followed by a section comprising an art/archaeological pigment and mineral substrate database.

A general conclusion from the meeting at the British Museum was that Raman spectroscopic techniques have a pivotal role in the non-destructive chemical analysis of materials relevant to art and archaeology. In 2003 and 2004 several major international meetings featured or have designated special themed sessions on this topic and a forthcoming meeting on the topic is planned in Paris in 2005.

A vital component of the British Museum meeting in 2001 was the synergy that existed between established Raman spectroscopists, conservation scientists, museum curators, archaeologists and art historians; the increased awareness of the analytical applications and possibilities that was evident from the lectures and active poster session is essential for future advancement of the Raman technique in this field.

It is noteworthy that several learned Journals have published original research papers on the theme of this book, including J. Raman Spectroscopy, Spectrochimica Acta, Vibrational Spectroscopy, J. Molecular Structure, Talanta, Analyst, Analytical Chimica Acta, Analytical Chemistry, Studies in Conservation, Archaeometry, Biochim. Biophys. Acta and Analytical Biochimica Acta. It is, therefore, very timely that this book appears in the literature and represents the first publication dedicated to the application of Raman spectroscopic techniques to art and archaeology; the contributions herein all originate from acknowledged

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international experts in their fields, with wide-ranging interdisciplinarities and the common theme of Raman spectroscopic application to analytical problems.

At the outset of commissioning this book, it was our noble intention that all the Raman spectra presented would conform to the IUPAC recommended format for display and labelling of axes, see Chapter 2. We realise that we have not fully achieved our goal, but have endeavoured, wherever possible, within reasonable constraints of time, availability of original data in electronic form, and cost-effectiveness, to meet the recommended standard. This was not possible with the extensive database featured in Chapter 25, but we feel sure that this will not detract from its usefulness. Other difficulties arose with some 'reproduced figures' – does copyright strictly allow one to modify or adapt figure axes, or should they be faithfully reproduced? We hope our 'failure' to meet our original high standard will not detract from the value of this book. We now realise how much simpler and easier our task in this respect would have been if spectrometer manufacturers adopted the recommended IUPAC format as their default output – a simple task, and a plea, please!

H.G.M.E
J.M.C.
June 2004

Abbreviations and Acronyms

AAS	Atomic absorption spectrometry
AD	*Anno Domini*
AES	Atomic emission spectroscopy
AGLAE	Accelerateur Grand Louvre d'Analyse Elementaire
AMS	Accelerator mass spectrometry
BC	Before Christ
BP	Before Present: BP = current year − year AD, or current year + year BC; *e.g.* in 2004 AD, 1500 BC≡3504 BP, and 1500 AD≡504 BP
CARS	Coherent anti-Stokes Raman scattering
CCD	Charge-coupled device
CNRS	Centre National de la Recherche Scientifique
DMTA	Dynamic mechanical thermal analysis
DRIFTS	Diffuse reflection infrared Fourier transform spectroscopy
DSC	Differential scanning calorimetry
DTA	Differential thermal analysis
ED	Energy-dispersive
EDS	Energy-dispersive spectroscopy/spectrometer
EDX	Energy-dispersive X-ray
EDXRF	Energy-dispersive X-ray fluorescence
EMP	Electron microprobe
EMPA	Electron microprobe analysis
EPXMA	Electron probe micro-analysis
FORS	Fibre optics reflectance spectroscopy
FT	Fourier transform
FT-IR	Fourier transform infrared
FT-Raman	Fourier transform Raman
FT-RS	Fourier transform Raman spectroscopy
FWHH	Full width at half height
FWHM	Full width at half maximum
GC-MS	Gas chromatography-mass spectrometry
HPLC	High-performance liquid chromatography
HPHT	High-pressure, high temperature
ICP	Inductively coupled plasma
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectroscopy
IMA	International Mineralogical Association
IR	Infrared
IRM	Immobile Raman microscope
IUGS	International Union of Geological Sciences
JCPDS	Joint Committee on Powder Diffraction Standards

LIBS	Laser-induced breakdown spectroscopy
LIFS	Laser-induced fluorescence spectroscopy
MCT	Mercury cadmium telluride
MNHN	Muséum National d'Histoire Naturelle
MRM	Mobile Raman microscopy
MS	Mass spectrometry
NAA	Neutron activation analysis
Near-IR/NIR	Near-infrared
OES	Optical emission spectroscopy
PIGE	Proton-induced gamma-ray emission
PIXE	Particle-induced X-ray emission
PC	Personal computer
PCA	Principal component analysis
PL	Photoluminescence
PLS	Partial least-squares
PMMA	Poly(methyl methacrylate)
PVA	Poly(vinyl acetate)
Py/GC-MS	Pyrolysis gas chromatography-mass spectrometry
RBS	Rutherford backscattering spectrometry
RM	Raman microscope/microscopy
RMP	Raman microprobe
RRS	Resonance Raman scattering
SEM	Scanning electron microscopy
SERS	Surface enhanced Raman scattering
SERRS	Surface enhanced resonance Raman spectroscopy
SIMS	Secondary ion mass spectrometry
S/N	Signal-to-noise ratio
SRXRF	Synchrotron radiation induced XRF
SSRS	Shifted, subtracted Raman spectroscopy
TEM	Transmission electron microscopy
TGA	Thermo-gravimetric analysis
THM	Thermally assisted hydrolysis methylation
TLC	Thin layer chromatography
TMA	Thermomechanical analysis
TOF-SIMS	Time-of-flight secondary ion mass spectrometry
UV	Ultra-violet
XANES	X-ray absorption near edge structure
XRD	X-ray diffraction
XRF	X-ray fluorescence
XPS	X-ray photoelectron spectroscopy

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