

PROCEEDINGS OF SPIE

Optics for Arts, Architecture, and Archaeology VI

**Luca Pezzati
Piotr Targowski**
Editors

**28–29 June 2017
Munich, Germany**

Sponsored by
SPIE

Cooperating Organisations
European Optical Society
German Scientific Laser Society (Wissenschaftliche
Gesellschaft Lasertechnik e.V.)

Published by
SPIE

Volume 10331

Proceedings of SPIE 0277-786X, V. 10331

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Optics for Arts, Architecture, and Archaeology VI, edited by Luca Pezzati,
Piotr Targowski, Proc. of SPIE Vol. 10331, 1033101 · © 2017 SPIE
CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2284529

Proc. of SPIE Vol. 10331 1033101-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Optics for Arts, Architecture, and Archaeology VI*, edited by Luca Pezzati, Piotr Targowski, Proceedings of SPIE Vol. 10331 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510611078
ISBN: 9781510611085 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2017, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/17/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be

fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

SESSION 1	INTEGRATED TECHNIQUES AND CASE STUDIES
10331 03	Nonintrusive tools to detect salts contamination in masonry: case study of Fontaine-Chaalis church [10331-2]
10331 04	Optical characterization of natural protective varnishes and their influences on perception of painted samples [10331-3]
SESSION 2	NEW METHODS AND APPLICATIONS FOR RESTORATION
10331 06	Bridging research with innovative products: a compact hyperspectral camera for investigating artworks: a feasibility study (Invited Paper) [10331-5]
10331 08	Quantitative assessment in thermal image segmentation for artistic objects [10331-7]
10331 09	Nondestructive evaluation of protective coatings for the conservation of industrial monuments [10331-8]
10331 0A	A versatile optical profilometer based on conoscopic holography sensors for acquisition of specular and diffusive surfaces in artworks [10331-9]
SESSION 3	3D IMAGING, SCANNING, TOPOGRAPHY, AND TOMOGRAPHY
10331 0C	Mapping the opacity of paint layers in paintings with coloured grounds using optical coherence tomography [10331-11]
10331 0D	High-resolution mobile optical 3D scanner with color mapping [10331-12]
SESSION 4	STRUCTURE AND MATERIAL ANALYSIS
10331 0G	Lock-in-shearography for the detection of transport-induced damages on artwork (Invited Paper) [10331-15]
10331 0H	Method for dating old handwritten manuscripts based on spectral photometry of ink in near infrared range [10331-16]
10331 0J	LIBS, Raman spectroscopy, and optical microscopy analyses of superficial encrustations on ancient tesserae in Lebanon [10331-18]

SESSION 5 STRATIGRAPHIC AND DEPTH-RESOLVED METHODS

10331 OK **3D internal reconstruction by the use of terahertz time domain imaging (THz-TDI): an application on a 15th century stucco relief (Invited Paper)** [10331-19]

10331 OL **Surface and subsurface layers characterization in artworks using conoscopic laser holography and acoustic microscopy** [10331-20]

10331 OM **In-depth analyses of paleolithic pigments in cave climatic conditions** [10331-21]

SESSION 6 METHODS AND INSTRUMENTS FOR THE UPCOMING EUROPEAN RESEARCH INFRASTRUCTURE FOR HERITAGE SCIENCE I

10331 ON **LIBS-LIF-Raman: a new tool for the future E-RIHS** [10331-22]

SESSION 7 METHODS AND INSTRUMENTS FOR THE UPCOMING EUROPEAN RESEARCH INFRASTRUCTURE FOR HERITAGE SCIENCE II

10331 OP **Analytical robustness of quantitative NIR chemical imaging for Islamic paper characterization** [10331-24]

10331 OR **Combination of interferometry and thermography data for cultural heritage structural diagnostic research** [10331-26]

10331 OS **Contribution of computed tomography to the investigation of La Tene culture iron artefacts** [10331-27]

10331 OT **Micro-XRF complemented by x-radiography and digital microscopy imaging for the study of hidden paintings** [10331-28]

POSTER SESSION

10331 OV **The hybrid thermography approach applied to architectural structures** [10331-30]

10331 OX **Power estimation of martial arts movement with different physical, mood, and behavior using motion capture camera** [10331-32]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Aghemo, C., 04
Ambrosini, D., 0V
Andrianakis, Michalis, 0R
Apostolidis, Georgios, 0L
Awang Soh, Ahmad Afiq Sabqi, 0X
Azraai, Nur Zaidi, 0X
Bai, Xueshi, 0N
Barsht, Konstantin, 0H
Berezkina, Svetlana, 0H
Bodnar, Jean-Luc, 03
Bormand, M., 0K
Bouquillon, A., 0K
Bourguignon, Elsa, 0N
Bräuer-Burchardt, Christian, 0D
Brissaud, Didier, 03, 0K
Buchta, D., 0G
Casini, Andrea, 06
Chmielewski, Krzysztof, 0J
Cucci, Costanza, 06
Daffara, Claudia, 0A, 0L
Detalle, Vincent, 0N, 0R
Dillmann, Christopher, 09
Fear, Thomas, 0P
Fořt, M., 0S
Gaburro, Nicola, 0A
Galeotti, Monica, 0L
Gariani, G., 0K
Gasanova, Svetlana, 0T
Gerhardt, Nils C., 09
Gilchrist, John R., 0P
Giovannacci, David, 03, 0K, 0R
Goubard, F., 0K
Groves, Roger M., 0C
Gurov, Igor, 0H
Hall-Aquitania, Moorea, 0C
Hatzigiannakis, Kostas, 0R
Heinemann, C., 0G
Hermens, Erma, 0C
Hermon, Sorin, 0T
Hofmann, Martin R., 09
Hoi Ching, M. Cheung, 0K
Iacomussi, P., 04
Jussila, Jouni, 06
Karagiannis, Georgios, 0L
Kosma, Kiki, 0R
Krekel, C., 0G
Kühmstedt, Peter, 0D
Kumpová, I., 0S
Lenz, Marcel, 09
Leroux, L., 0K
Liu, Ping, 0C
Mahgoub, Hend, 0P
Maldague, Xavier P. V., 08
Marchioro, Giacomo, 0A, 0L
Mat Jafri, Mohd Zubir, 0X
Mazzon, Cristian, 09
Menu, Michel, 0N
Mertz, Jean-Didier, 03
Mouhoubi, Kamel, 03
Mularczyk-Oliwa, Monika, 0J
Nardi, I., 0V
Notni, Gunther, 0D
Osten, W., 0G
Ostrowski, Roman, 0J
Pallot-Frossard, Isabelle, 0N
Paoletti, D., 0V
Pasqualoni, G., 0V
Pedrini, G., 0G
Picollo, Marcello, 06
Prange, Michael, 09
Radis, M., 04
Ramm, Roland, 0D
Rossi, G., 04
Sankot, P., 0S
Sferra, Stefano, 08, 0V
Skrzyczanowski, Wojciech, 0J
Stefani, Lorenzo, 06
Strlić, Matija, 0P
Strzelec, Marek, 0J
Syvilay, Delphine, 0M
Tomkowska, Anna, 0J
Tornari, Vivi, 0R
Touron, Stéphanie, 0M
Trichereau, Barbara, 0M
Vavřik, D., 0S
Volkov, Mikhail, 0H
Vopálenký, M., 0S
Welp, Hubert, 09
Yousefi, Bardia, 08

Conference Committee

Symposium Chair

Wolfgang Osten, Universität Stuttgart (Germany)

Conference Chairs

Luca Pezzati, Istituto Nazionale di Ottica-CNR (Italy)

Piotr Targowski, Nicolaus Copernicus University (Poland)

Conference Program Committee

Dario Ambrosini, Università degli Studi dell'Aquila (Italy)

John F. Asmus, University of California, San Diego (United States)

Brunetto Giovanni Brunetti, Università degli Studi di Perugia (Italy)

Marta Castillejo, Instituto de Química Física Rocasolano, CSIC (Spain)

Alberto de Tagle, Netherlands Institute for Cultural Heritage
(Netherlands)

Vincent Detalle, Centre de Recherche et de Restauration des
Musées de France (C2RMF) (France)

John K. Delaney, National Gallery of Art (United States)

Raffaella E. M. Fontana, Istituto Nazionale di Ottica (Italy)

Roger Groves, Technische Universiteit Delft (Netherlands)

Igor P. Gurov, ITMO University (Russian Federation)

Alexander J. Kossolapov, State Hermitage Museum
(Russian Federation)

Haida Liang, Nottingham Trent University (United Kingdom)

Nicola Masini, Consiglio Nazionale delle Ricerche (Italy)

David R. Saunders, International Institute for Conservation
(United Kingdom)

Robert Sitnik, Warsaw University of Technology (Poland)

Heike Stege, Doerner Institut (Germany)

Vivi Tornari, Foundation for Research and Technology-Hellas
(Greece)

Session Chairs

1 Integrated Techniques and Case Studies

Marta Castillejo, Instituto de Química Física Rocasolano, CSIC (Spain)

- 2 New Methods and Applications for Restoration
Vincent Detalle, Centre de Recherche et de Restauration des
Musées de France (C2RMF) (France)
Marta Castillejo, Instituto de Química Física Rocasolano, CSIC (Spain)
- 3 3D Imaging, Scanning, Topography, and Tomography
Haida Liang, Nottingham Trent University (United Kingdom)
- 4 Structure and Material Analysis
John K. Delaney, National Gallery of Art (United States)
- 5 Stratigraphic and Depth-resolved Methods
Roger M. Groves, Technische Universiteit Delft (Netherlands)
- 6 Methods and Instruments for the Upcoming European Research
Infrastructure for Heritage Science I
Luca Pezzati, Istituto Nazionale di Ottica (Italy)
- 7 Methods and Instruments for the Upcoming European Research
Infrastructure for Heritage Science II
Luca Pezzati, Istituto Nazionale di Ottica (Italy)