

PROGRESS IN BIOMEDICAL OPTICS AND IMAGING

Vol. 9, No. 29

***Design and Performance
Validation of Phantoms Used
in Conjunction with Optical
Measurements of Tissue***

Robert J. Nordstrom

Editor

19–21 January 2008

San Jose, California, USA

Sponsored and Published by
SPIE

Volume 6870

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Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Design and Performance Validation of Phantoms Used in Conjunction with Optical Measurements of Tissue*, edited by Robert J. Nordstrom, Proceedings of SPIE Vol. 6870 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 1605-7422

ISBN 9780819470454

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

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Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

SESSION 1 DYNAMIC PHANTOMS AND ENGINEERED TISSUE

- 6870 02 **Validation of near infrared spectroscopic (NIRS) imaging using programmable phantoms (Invited Paper)** [6870-01]
R. L. Barbour, R. Ansari, NIRx Medical Technologies LLC (USA) and SUNY, Downstate Medical Ctr. (USA); R. Al abdi, SUNY, Downstate Medical Ctr. (USA); H. L. Graber, NIRx Medical Technologies LLC (USA) and SUNY, Downstate Medical Ctr. (USA); M. B. Levin, SUNY, Downstate Medical Ctr. (USA); Y. Pei, NIRx Medical Technologies, LLC (USA); C. H. Schmitz, Charité-Universitätsmedizin, Berlin (Germany); Y. Xu, NIRx Medical Technologies LLC (USA) and SUNY, Downstate Medical Ctr. (USA)
- 6870 03 **Dynamically programmable digital tissue phantoms** [6870-03]
S. W. Brown, J. P. Rice, D. W. Allen, National Institute of Standards and Technology (USA); K. Zuzak, Univ. of Texas at Arlington (USA); E. Livingston, Univ. of Texas Southwestern Medical Ctr. (USA); M. Litorja, National Institute of Standards and Technology (USA)
- 6870 04 **Structural and biochemical characterization of engineered tissue using FTIR spectroscopic imaging: melanoma progression as an example (Invited Paper)** [6870-04]
R. Bhargava, R. Kong, Univ. of Illinois at Urbana-Champaign (USA)

SESSION 2 DESIGN AND VALIDATION OF PHANTOMS

- 6870 05 **Regulatory perspectives and research activities at the FDA on the use of phantoms with in vivo diagnostic devices** [6870-05]
A. Agrawal, M. A. Gavrielides, S. Weininger, K. Chakrabarti, J. Pfefer, U.S. Food and Drug Administration (USA)
- 6870 06 **Turbid-polyurethane phantom for microscopy** [6870-06]
A. L. Dayton, S. A. Prahl, Oregon Health and Science Univ. (USA)
- 6870 07 **Fabrication and characterization of silicone-based tissue phantoms with tunable optical properties in the visible and near infrared domain** [6870-07]
F. Ayers, A. Grant, D. Kuo, Laser Microbeam and Medical Program, Beckman Laser Institute, Univ. of California, Irvine (USA); D. J. Cuccia, Modulated Imaging, Inc. (USA) and Beckman Laser Institute Photonic Incubator (USA); A. J. Durkin, Laser Microbeam and Medical Program, Beckman Laser Institute, Univ. of California, Irvine (USA)
- 6870 08 **Gel phantom in selective laser phototherapy** [6870-08]
Y. Chen, C. A. Bailey, T. M. Cowan, Univ. of Central Oklahoma (USA); F. Wu, Chongqing Medical Univ. (China); H. Liu, Univ. of Oklahoma (USA); R. A. Towner, Oklahoma Medical Research Foundation (USA); W. R. Chen, Univ. of Central Oklahoma (USA)

SESSION 3 PHANTOMS FOR OCT AND FLUORESCENCE MEASUREMENTS

- 6870 0A **Deformable and durable optical phantoms with controlled density of scatterers** [6870-10]
C.-É. Biscaillon, National Research Council Canada (Canada); G. Lamouche, M.-M. Lanthier, National Research Council Canada (Canada) and Ecole Polytechnique de Montréal (Canada); D. Lévesque, National Research Council Canada (Canada); R. Maciejko, Ecole Polytechnique de Montréal (Canada); J.-P. Monchalin, National Research Council Canada (Canada)
- 6870 0C **A calibrated tissue phantom for small animal fluorescence imaging** [6870-12]
S. Leavesley, J. P. Robinson, Purdue Univ. (USA)
- 6870 0D **Novel tissue phantom for testing a dual-modality diagnostic system: time-resolved fluorescence spectroscopy and high frequency ultrasound** [6870-13]
Y. Sun, K.-C. Liao, Y. Sun, J. Park, L. Marcu, Univ. of California, Davis (USA)
- 6870 0E **An accurate homogenized tissue phantom for broad spectrum autofluorescence studies: a tool for optimizing quantum dot-based contrast agents** [6870-14]
M. Roy, Univ. of Toronto (Canada); B. C. Wilson, Univ. of Toronto (Canada) and Ontario Cancer Institute, Univ. Health Network (Canada)
- 6870 0F **Phantoms for polarized light exhibiting controllable scattering, birefringence, and optical activity** [6870-15]
M. F. G. Wood, N. Ghosh, X. Guo, I. A. Vitkin, Ontario Cancer Institute, Univ. Health Network and Univ. of Toronto (Canada)

SESSION 4 SCATTERING SIMULATIONS IN PHANTOMS

- 6870 0G **Evaluating optical properties of isolated biological scatterers from confocal and low-coherence images** [6870-16]
D. Levitz, R. Samatham, M. T. Hinds, S. L. Jacques, Oregon Health and Science Univ. (USA)
- 6870 0H **Microscopic heterogeneity vs. macroscopic homogeneity in tissue phantoms using reflectance-mode confocal scanning laser microscopy** [6870-17]
R. Samatham, D. Levitz, Oregon Health and Science Univ. (USA); R. Fletcher, Univ. of Pennsylvania (USA); Y. Fu, S. L. Jacques, Oregon Health and Science Univ. (USA)
- 6870 0I **Quantitative endoscopic imaging elastic scattering spectroscopy: model system/tissue phantom validation** [6870-18]
E. H. Lindsley, D. L. Farkas, Cedars-Sinai Medical Ctr. (USA)

SESSION 5 UNIQUE PHANTOM DESIGNS AND USES

- 6870 0K **Review of phantoms for tomographic imaging, with applications toward diffuse spectroscopy within clinical imaging systems** [6870-20]
B. W. Pogue, S. Jiang, Dartmouth College (USA); H. Dehghani, Dartmouth College (USA) and Univ. of Exeter (United Kingdom); K. D. Paulsen, Dartmouth College (USA)

- 6870 0M **Optical phantoms for ultrasound-modulated optical tomography** [6870-22]
C. Kim, Washington Univ. in St. Louis (USA); A. Garcia-Uribe, Texas A&M Univ. (USA);
S.-R. Kothapalli, L. V. Wang, Washington Univ. in St. Louis (USA)
- 6870 0N **Calibration of an eye oximeter with a dynamic eye phantom** [6870-23]
A. Nabili, D. Bardakci, K. Helling, C. Matyas, S. Muro, J. C. Ramella-Roman, The Catholic
Univ. of America (USA)
- 6870 0O **Diffuse optical tomography and spectroscopy performance assessment: phantoms and
methodology** [6870-24]
N. Mincu, J. Brunette, O. Guilman, F. Leblond, S. Djeziri, Z. Ichalalène, G. Ma, M. Khayat,
A. Benyamin-Seeyar, ART Advanced Research Technologies Inc. (Canada)

POSTER SESSION

- 6870 0P **Static and dynamic light scattering properties of Intralipid aqueous suspension for tissue
phantom preparation and calibration** [6870-25]
I. Delfino, Univ. della Tuscia (Italy); R. Esposito, B. Piccirillo, Univ. di Napoli Federico II (Italy);
G. M. Gaeta, M. Lepore, Seconda Univ. di Napoli (Italy)

Author Index

Conference Committee

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Session Chairs

- 1 Dynamic Phantoms and Engineered Tissue
Gerald T. Fraser, National Institute of Standards and Technology (USA)
Robert J. Nordstrom, National Institutes of Health (USA)
- 2 Design and Validation of Phantoms
William W. Mantulin, University of California, Irvine (USA)
Robert J. Nordstrom, National Institutes of Health (USA)
- 3 Phantoms for OCT and Fluorescence Measurements
Mary-Ann Mycek, University of Michigan (USA)
Brian W. Pogue, Dartmouth College (USA)

4 Scattering Simulations in Phantoms
Scott A. Prahl, Providence St. Vincent Medical Center (USA)
Anant Agrawal, U.S. Food and Drug Administration (USA)

5 Unique Phantom Designs and Uses
William W. Mantulin, University of California, Irvine (USA)
Robert J. Nordstrom, National Institutes of Health (USA)

Poster Session

Robert J. Nordstrom, National Institutes of Health (USA)

Introduction

This was the first year for this conference on optical phantoms. The 24 presentations were arranged into five sessions covering a wide range of topics in phantom design and use. Presenters were in agreement that the phantoms must accurately mimic absorption and scattering characteristics of tissue within a desired spectral region, but the methods for achieving these tissue characteristics varied. TiO_2 remains a favorite compound for creating scattering in phantoms, and India ink is a useful absorber. However, when more complex tissue qualities such as polarization reflectance or oxy- deoxy-hemoglobin ratio are to be simulated, the phantoms themselves become more complex. This conference attracted speakers with backgrounds in these and other uses of phantoms, making the conference timely and interesting to a broad audience.

The opening session focused on dynamic phantoms needed for optimization of device performance for *in vivo* studies. Two invited presentations demonstrated that there are several ways to approach the need to mimic active properties of tissue such as blood perfusion or biochemical processes. Dr. Randall Barbour presented data showing that liquid crystal devices embedded in geometrically accurate phantoms can simulate the dynamics of hemoglobin in large tissue structures for near infrared measurements. In the second invited presentation of the opening session, Dr. Rohit Bhargava suggested the use of engineered tissue as a suitable phantom with dynamic properties and sufficient lifetime to be useful.

Both the National Institute for Standards and Technology (NIST) and the Food & Drug Administration (FDA) are active stakeholders in the development and use of phantoms for device performance testing. A Hyperspectral Image Projector (HIP) was described by Dr. Steven Brown of NIST. Here, a quantitative image containing the spectral information in each pixel, rather than simply an image color rendition can be projected for testing of spectroscopic devices designed for diagnosis or screening. Dr. Agrawal of the FDA gave a detailed overview of the successes experienced by the use of phantoms in other imaging methodologies, and challenged the optical community to follow these examples.

Optical phantoms designed specifically for use with a particular optical imaging methodology must not only mimic the bulk properties of the tissue, but must also duplicate the finer qualities interrogated by the optical technique. Polarization measurements represent just such a challenge to phantom construction. Not only must these phantoms give faithful representation to the scattering and absorption properties of the tissue, but they must also duplicate polarization and depolarization characteristics of the tissue. These and other specific topics were presented in a special session.

Finally, multimodal devices that combine different imaging methodologies to gain sensitivity and specificity offer unique difficulties when attempting to create accurate phantoms. Not only must the phantom imitate a set of tissue characteristics for one imaging method, it must also imitate the tissue characteristics of the other imaging method as well. Chulhong Kim presented results of his work to create tissue phantoms to mimic the optical and acoustic properties of phantoms for his studies of the optical and ultrasound characteristics of tissue.

The planning committee judged this first presentation of a forum for discussing optical phantom design and use to be a success. It was recommended that the conference be repeated next year.

Robert J. Nordstrom