

PROCEEDINGS OF SPIE

***Optical System Contamination:
Effects, Measurements, and
Control 2010***

**Sharon A. Straka
Nancy Carosso**
Editors

**2–5 August 2010
San Diego, California, United States**

Sponsored and Published by
SPIE

Volume 7794

Proceedings of SPIE, 0277-786X, v. 7794

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

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Optical System Contamination: Effects, Measurements, and Control 2010*, edited by Sharon A. Straka, Nancy Carosso, Proceedings of SPIE Vol. 7794 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X
ISBN 9780819482907

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 © 2010, 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/10/\$18.00.

Printed in the United States of America.

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

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>
xi	<i>A Contamination Engineering Tribute to Don Wallace</i>

SESSION 1 CONTAMINATION EFFECTS I

7794 02	Optical characterization of condensed RTV effluent as a function of temperature [7794-01] N. J. Ianno, J. Pu, F. Zhou, Univ. of Nebraska-Lincoln (United States)
7794 03	Lessons learned for the NASA Mission Solar Dynamics Observatory [7794-02] R. B. Rivera, NASA Goddard Space Flight Ctr. (United States); D. Uhl, M. Secunda, Stinger Ghaffarian Technologies, Inc. (United States)
7794 04	Preservation of thermal control specular gold baffle surface on the James Webb Space Telescope (JWST) integrated science instrument module (ISIM) electronics compartment (IEC) [7794-03] K. Montt de Garcia, J. Patel, R. Perry III, Stinger Ghaffarian Technologies, Inc. (United States)
7794 05	Long-term laser irradiation tests of optical elements for ESA mission ADM-Aeolus [7794-04] U. Leinhos, K. Mann, A. Bayer, Laser-Lab. Göttingen e.V. (Germany); M. Endemann, D. Wernham, F. Pettazzi, European Space Research and Technology Ctr. (Netherlands); D. Thibault, EADS Astrium (France)
7794 06	Aerosol Polarimeter Sensor (APS) contamination control requirements and implementation [7794-05] J. P. Elders, H. M. Azene, G. T. Betraun, K. J. Wilkerson, Raytheon Space & Airborne Systems (United States)

SESSION 2 CONTAMINATION EFFECTS II

7794 08	Contamination impact of station brush fire on cleanroom facilities [7794-08] P. A. Carey, B. K. Blakkolb, Jet Propulsion Lab. (United States)
7794 09	Contaminant film deposition on VUV-modified surfaces [7794-09] D. J. Coleman, K. T. Luey, The Aerospace Corp. (United States)

SESSION 3 CONTAMINATION CONTROL, MONITORING, AND VERIFICATION I

7794 0B	Zeolite adsorbers for molecular contamination control in spacecraft [7794-10] D. Faye, Ctr. National d'Études Spatiales (France); A. Jakob, M. Soulard, Ecole Nationale Supérieure de Chimie de Mulhouse (France); P. Berlioz, EADS Astrium (France)
---------	--

- 7794 0C **Development of molecular adsorber coatings** [7794-11]
S. Straka, W. Peters, M. Hasegawa, NASA Goddard Space Flight Ctr. (United States);
K. Novo-Gradac, A. Wong, Stinger Ghaffarian Technologies, Inc. (United States)
- 7794 0E **Purge system for Landsat Data Continuity Mission and other instruments in contamination**
[7794-37]
J. Orellana, R. B. Rivera, NASA Goddard Space Flight Ctr. (United States)

SESSION 4 ANTI-CONTAMINATION/PROTECTIVE COATINGS

- 7794 0F **Properties of Ball InfraRed Black, a new cryogenic thermal control coating** [7794-13]
M. Renbarger, Ball Aerospace & Technologies Corp. (United States)
- 7794 0G **Reducing particle adhesion by material surface engineering** [7794-14]
M. S. Crowder, R. Stover, A. Lawitzke, G. Devaud, Ball Aerospace & Technologies Corp.
(United States); A. Dove, X. Wang, Univ. of Colorado at Boulder (United States)
- 7794 0H **Tailoring of superhydrophilic to superhydrophobic coating morphologies for space
exploration contamination control** [7794-15]
R. Pirich, J. Weir, D. Leyble, S. Chu, Northrop Grumman Aerospace Systems (United States)
- 7794 0I **The Lotus coating for space exploration: a dust mitigation tool** [7794-16]
D. V. Margiotta, W. C. Peters, S. A. Straka, M. Rodriguez, NASA Goddard Space Flight Ctr.
(United States); K. R. McKittrick, C. B. Jones, Stinger Ghaffarian Technologies, Inc. (United
States)

SESSION 5 CONTAMINATION CONTROL, MONITORING, AND VERIFICATION II

- 7794 0K **A dynamic approach to monitoring particle fallout in a cleanroom environment** [7794-18]
R. L. Perry III, Stinger Ghaffarian Technologies, Inc. (United States)
- 7794 0M **Infiltration of supermicron aerosols into a simulated space telescope** [7794-20]
D.-L. Liu, K. T. Luey, The Aerospace Corp. (United States)
- 7794 0N **Concepts for a NASA applied spaceflight environments office** [7794-36]
D. L. Edwards, H. D. Burns, M. Xapsos, J. F. Spann, NASA Marshall Space Flight Ctr. (United
States)

SESSION 6 CONTAMINATION ANALYSIS/SPACE ENVIRONMENTS

- 7794 0O **Development of versatile molecular transport model for modeling spacecraft
contamination** [7794-22]
C. W. Chang, K. Kannenberg, M. H. Chidester, Lockheed Martin Space Systems Co. (United
States)
- 7794 0P **Analysis of particulate contamination during launch of the MMS mission** [7794-23]
L. Brieda, A. Barrie, Millennium Engineering and Integration Co. (United States); D. Hughes,
T. Errigo, NASA Goddard Space Flight Ctr. (United States)

7794 0Q **Bus vent design evolution for the Solar Dynamics Observatory** [7794-24]
M. Woronowicz, Stinger Ghaffarian Technologies, Inc. (United States)

7794 0R **Comparison of measured and analytical ultraviolet light attenuation** [7794-25]
J. T. Sanders, ATK Space Systems (United States)

SESSION 7 STRAY LIGHT IN OPTICAL SYSTEMS I

7794 0T **Deterministic sequential stray light analysis** [7794-27]
M. G. Dittman, E. Donley, F. Grochocki, Ball Aerospace & Technologies Corp. (United States)

7794 0V **Scattering from moderately rough interfaces between two arbitrary media** [7794-29]
J. E. Harvey, N. Choi, A. Krywonos, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States)

SESSION 8 STRAY LIGHT IN OPTICAL SYSTEMS II

7794 0W **Stray light testing of the OLI Telescope** [7794-30]
F. Grochocki, J. Fleming, Ball Aerospace & Technologies Corp. (United States)

7794 0X **Study on the ghost images spatial distribution in high power laser facilities** [7794-31]
Y. Zhang, Shanghai Institute of Optics and Fine Mechanics (China) and Graduate Univ. of the Chinese Academy of Sciences (China); Y. Ma, Y. Zhang, Shanghai Institute of Optics and Fine Mechanics (China); P. Sun, Shanghai Institute of Optics and Fine Mechanics (China) and Graduate Univ. of the Chinese Academy of Sciences (China); X. Li, J. Zhu, Shanghai Institute of Optics and Fine Mechanics (China)

Author Index

Conference Committee

Program Track Chair

José Sasian, College of Optical Sciences, The University of Arizona
(United States)

Conference Chairs

Sharon A. Straka, NASA Goddard Space Flight Center (United States)
Nancy Carosso, NASA Goddard Space Flight Center (United States)

Program Committee

Mark T. Boies, Research Support Instruments, Inc. (United States)
H. Dewitt Burns, Jr., NASA Marshall Space Flight Center (United States)
Joanne Egges, Ball Aerospace & Technologies Corporation (United States)
Wanda C. Peters, NASA Goddard Space Flight Center (United States)
Carlos E. Soares, The Boeing Company (United States)
David P. Taylor, The Aerospace Corporation (United States)
O. Manuel Uy, The Johns Hopkins University (United States)

Session Chairs

- 1 Contamination Effects I
Nancy Carosso, NASA Goddard Space Flight Center (United States)
Joanne Egges, Ball Aerospace & Technologies Corporation (United States)
- 2 Contamination Effects II
Mark T. Boies, Research Support Instruments, Inc. (United States)
- 3 Contamination Control, Monitoring, and Verification I
Nancy Carosso, NASA Goddard Space Flight Center (United States)
- 4 Anti-Contamination/Protective Coatings
Joanne Egges, Ball Aerospace & Technologies Corporation (United States)
- 5 Contamination Control, Monitoring, and Verification II
David P. Taylor, The Aerospace Corporation (United States)

- 6 Contamination Analysis/Space Environments
Danielle V. Margiotta, NASA Goddard Space Flight Center (United States)
- 7 Stray Light in Optical Systems I
John C. Fleming, Ball Aerospace & Technologies Corporation (United States)
- 8 Stray Light in Optical Systems II
Richard N. Pfisterer, Photon Engineering LLC (United States)

Introduction

In August 2010 the Contamination, Optical Degradation, and Optical Stray Light communities gathered together in San Diego to participate in another extraordinary SPIE conference on Optical System Contamination: Effects, Measurements, and Control 2010.

During the first day and a half, many papers on a wide variety of subjects were presented, including: contamination effects; contamination control, monitoring, and verification; analytical modeling of space environments, and new technology advancements in anti-contamination and protective coatings. The individual sessions were chaired by leaders of state-of-the-art research in the Contamination community, and healthy discussions after each paper were conducted.

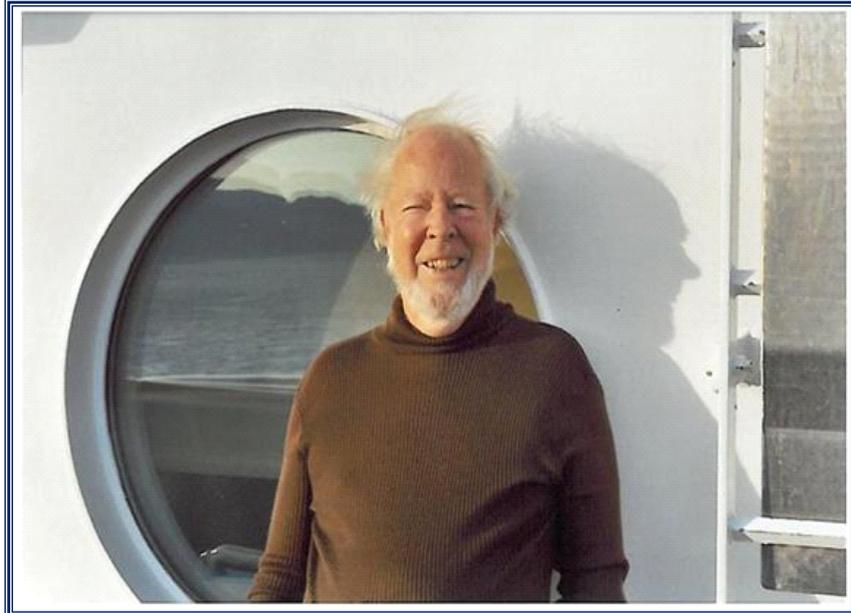
A centerpiece in the program was a touching commemorative session in honor of Mr. Don Wallace, who passed away this year. Don Wallace was a founder and leader in the development and application of quartz crystal microbalances and other contamination measurement devices, over many decades, in support of our nation's space program. The Wallace family was in attendance to receive engraved plaques and crystal statues in honor of their father and grandfather. Mr. Manny Uy gave a moving tribute summarizing the valuable accomplishments and services provided by Mr. Wallace throughout his lifetime.

On the final day of the program, a host of presenters and attendees participated in the Stray Light in Optical Systems sessions. Papers on stray light modeling as well as new methods to reduce stray light within optical systems were presented. Experts in the field were in attendance and excellent technical interchange among the audience ensued following the presentations.

The program chairs have an exciting plan for SPIE Optics + Photonics 2012, including interactive sessions and panels with world-renowned experts in the contamination, anti-contamination and thermal coatings, and optical degradation fields. Please plan on attending and participating!

Sharon A. Straka
Nancy Carosso

A Contamination Engineering Tribute to Don Wallace



This tribute is for Don Wallace, a pioneer in the field of contamination sensing, who died suddenly last July 20, 2009 in Victoria, British Columbia, Canada. Don devoted almost six decades of passionate research and work in the aeronautical engineering industry, analytical design, and contamination. He was a graduate of the University of Wyoming with a degree in Mechanical and Aeronautical Engineering, he went on to receive his Masters in Aeronautics from CALTECH.

Don Wallace's professional career began with applied research work on combustion and supersonic inlets with the USC Engineering Center (now the Jet Propulsion Laboratory). He played an essential part in the beginning of quartz crystal microbalance (QCM) research and development in the early 1960s under the name of Celesco, and later, Berkeley Industries. The first QCM produced was for a momentum flux experiment with plasma flow. Realizing the potential value of QCMs for detecting molecular flux in both ground-based vacuum systems and in space, Don began developing a full spectrum of QCMs and their associated data collection equipment.

He was involved with NASA's Space Shuttle, the 1971 Skylab program, and various Air Force and international satellites in the early 1970s, all using an early line of QCM Sensors. He played an integral part in the design, building, and inspection of Japan's NASDA Space Chamber in 1972 and the India ISA High Vacuum Chamber in 1982–83.

out our door as a piece of art, as perfect as we could possibly make it. He made that work ethic an integral part of what his company was about, and we will continue to strive to meet his high standards.

Although Don retired several years ago, he continued to do the work he so loved—the research and development of new and improved designs to meet challenging, new industries.

As was his dream, Don worked until the very end. He would not have had it any other way. A brilliant scientist, pioneer, and respected leader, his legacy will live on in his family, in his company, and in his tremendous contribution to the industry. I have known Don Wallace since 1985 and have worked with his quartz crystal microbalances on many programs such as MSX, VIP, SM3 and even ground monitoring of rocket plumes. He has never tired on developing new uses for the QCMs and was always willing to work with us no matter how challenging the requirements or schedule. He and his son, Scott, had pulled me out of many uncomfortable moments when cost and schedule became short. For that and for everything else that he has done for our community, thank you, Don Wallace!

Manny Uy

The Johns Hopkins University APL

