

# SYMPOSIUM LL

## Rapid Prototyping Technologies III

December 3 – 5, 2002

### Chairs

Alberto Piqué Naval Research Laboratory  
Andrew S. Holmes Imperial College  
Duane Dimos Sandia Natl Laboratories  
Fritz B. Prinz Stanford Univ

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\* Invited paper

### SESSION LL1: LAYER MANUFACTURING AND SELECTIVE LASER SINTERING

Chair: Duane Dimos  
Tuesday Morning, December 3, 2002  
Gardner (Sheraton)

#### 8:30 AM \*LL1.1

MICROSTEREOLITHOGRAPHY: A REVIEW. Arnaud Bertsch,  
Sebastien Jiguet, Philippe Renaud, Swiss Federal Institute of  
Technology (EPFL), LMIS-STI, Lausanne, SWITZERLAND; Paul  
Bernhard, Proform AG, Marly, SWITZERLAND.

#### 9:00 AM LL1.2

RAPID MANUFACTURING WITH DIRECT METAL LASER  
SINTERING. Jan-Erik Lind, Jouni Hanninen, Juha Kotila, Olli  
Nyrhila and Tatu Syvanen, EOS Finland, Rapid Manufacturing  
Development Group, Rusko, FINLAND.

#### 9:15 AM \*LL1.3

LASER-BASED MASKLESS MICROFABRICATION OF  
ELECTRONIC ELEMENTS AND MECHANICAL COMPONENTS.  
Xiaochun Li, Yong Yang, Hongseok Choi, University of Wisconsin-  
Madison, Department of Mechanical Engineering, Madison, WI.

#### 9:45 AM BREAK

#### 10:00 AM \*LL1.4

LAYERED MANUFACTURING: CHALLENGES AND  
OPPORTUNITIES. Khershed P. Cooper, Naval Research Laboratory,  
Materials Science and Technology Division, Washington, DC.

#### 10:30 AM LL1.5

ALUMINA-DOPED SILICA GRADIENT-INDEX (GRIN) LENSES  
BY SLURRY-BASED THREE-DIMENSIONAL PRINTING  
(S-3DP<sup>TM</sup>). Hong-Ren Wang and Michael J. Cima, Department of  
Materials Science and Engineering; Emanuel M. Sachs, Department of  
Mechanical Engineering, Massachusetts Institute of Technology,  
Cambridge, MA.

#### 10:45 AM \*LL1.6

ROBOCASTING APPROACHES FOR FABRICATING 3D STATIC  
AND TUNABLE DIELECTRIC GHz-THz PHOTONIC BAND GAP  
STRUCTURES. P.G. Clem, J. Cesarano, J.E. Smay, J.F. Carroll,  
M.K. Niehaus, J.M. Rivera, and S.Y. Lin, Sandia National  
Laboratories, Albuquerque, NM.

#### 11:15 AM LL1.7

MANUFACTURING OF MICRO-SIZED GOLD STRUCTURES BY  
LASER CURING OF DISCRETELY DEPOSITED NANO-  
PARTICLES-SUSPENSION. Nicole R. Bieri, Stephan E. Haferl,

Dimos Poulidakos, Laboratory of Thermodynamics in Emerging  
Technologies, Institute of Energy Technology, Swiss Federal Institute  
of Technology, Zurich, SWITZERLAND; Costas P. Grigoropoulos,  
Department of Mechanical Engineering, University of California,  
Berkeley, CA.

#### 11:30 AM LL1.8

THERMAL AND STRESS MODELING OF SELECTIVE LASER  
SINTERING PROCESS. Ameer K. Ibraheem, Brian Derby,  
Manchester Materials Science Centre, University of Manchester and  
UMIST, Manchester, UNITED KINGDOM.

#### 11:45 AM LL1.9

SURFACE FINISH MECHANISMS DURING LASER POLISHING  
OF INDIRECT-SLS METAL PARTS. J.A. Ramos, D.L. Bourell, J.J.  
Beman, Laboratory for Freeform Fabrication, University of Texas at  
Austin, Austin, TX.

### SESSION LL2: SOLUTION AND SPRAY PROCESSING

Chair: Craig B. Arnold  
Tuesday Afternoon, December 3, 2002  
Gardner (Sheraton)

#### 1:30 PM \*LL2.1

RAPID PROTOTYPING AND FABRICATION OF MESOSCALE  
ELECTRONIC MULTILAYERS AND SENSORS THROUGH  
DIRECT WRITE THERMAL SPRAY. Sanjay Sampath, Center for  
Thermal Spray Research, Department of Materials Science and  
Engineering, State University of New York, Stony Brook, NY.

#### 2:00 PM LL2.2

LASER-ASSISTED SOLID FREEFORM FABRICATION OF 2-D  
AND 3-D SELF-ASSEMBLED MICROPARTICLE ARRAYS.  
Erik Geiss, University of Connecticut, Institute of Materials Science,  
Storrs, CT; ShiFeng Hou, University of Connecticut, Institute of  
Materials Science, Storrs, CT; Fotis Papadimitrakopoulos, University  
of Connecticut, Institute of Materials Science, Storrs, CT; Harris  
Marcus, University of Connecticut, Institute of Materials Science,  
Storrs, CT.

#### 2:15 PM LL2.3

NANOPARTICLE AND POLYELECTROLYTE GELS: NEW INKS  
FOR DIRECTED ASSEMBLY OF 3-D PERIODIC STRUCTURES.  
Gregory M. Gratson, Robert F. Shepherd, Qi Li, and Jennifer A.  
Lewis, Univ of Illinois, Dept of Materials Science and Engineering,  
Urbana, IL.

#### 2:30 PM LL2.4

DIRECT PATTERNING OF BARIUM TITANATE FILMS BY  
LASER-ACTIVATED ELECTROCHEMICAL REACTIONS IN  
AQUEOUS SOLUTIONS. Tomoaki Watanabe, Michiyo Kamiya, Ryo  
Teranishi, Takeshi Fujiwara and Masahiro Yoshimura, Materials and  
Structures Laboratory, Tokyo Institute of Technology, Yokohama,  
JAPAN.

#### 2:45 PM BREAK

#### 3:15 PM \*LL2.5

DIRECT FABRICATION OF PATTERNED FUNCTIONAL  
CERAMICS FILM BY SOFT SOLUTION PROCESSING WITHOUT  
FIRING. Masahiro Yoshimura, Tomoaki Watanabe, Takeshi  
Fujiwara, and Ryo Teranishi, Center for Materials Design, Materials  
and Structures Laboratory, Tokyo Institute of Technology, Yokohama,  
JAPAN.

#### 3:45 PM \*LL2.6

COLD GAS DYNAMIC MANUFACTURING: A NEW APPROACH  
TO DIRECT METAL DEPOSITION. Rhys Morgan, James Pattison,  
Carrie Gallacher, Adam Papworth, Matt Murphy, Chris Sutcliffe,  
Peter Fox, William O'Neill, Manufacturing Science and Engineering  
Research Centre, Dept of Engineering, University of Liverpool,  
UNITED KINGDOM.

#### 4:15 PM LL2.7

INTERFACIAL EFFECTS IN Ba<sub>1-x</sub>Sr<sub>x</sub>TiO<sub>3</sub> CERAMICS  
PREPARED BY PLASMA SPRAY. Kipyung Ahn, Bruce W. Wessels,  
Northwestern Univ, Dept of Materials Science and Engineering,  
Evanston, IL; Robert Greenlaw, Integrated Coating Solutions,  
Huntington Beach, CA; Sanjay Sampath, SUNY-Stony Brook, Dept of  
Materials Science and Engineering, Stony Brook, NY.

SESSION LL3: DIRECT-WRITE OF  
MICROELECTRONICS  
Chair: Andrew S. Holmes  
Wednesday Morning, December 4, 2002  
Gardner (Sheraton)

**8:30 AM \*LL3.1**

LASER ADDITIVE PATTERNING: OPTIONS AND OPPORTUNITIES FOR THE CONSUMER ELECTRONICS INDUSTRY. Willem Hoving, Philips Electronics Nederland B.V., Centre for Industrial Technology-CFT, Eindhoven, THE NETHERLANDS.

**9:00 AM \*LL3.2**

FUTURE GROWTH OPPORTUNITIES FOR THE PRINTING INDUSTRY IN MICROELECTRONICS. Paul Brazis, Krishna Kalyanasundaram, Jie Zhang, Daniel Gamota, Motorola Advanced Technology Center, Schaumburg, IL.

**9:30 AM LL3.3**

FABRICATION OF PALLADIUM-BASED MICROELECTRONIC DEVICES BY MICROCONTACT PRINTING. Daniel B. Wolfe, J. Christopher Love, Kateri E. Paul, Michael L. Chabinyc, George M. Whitesides, Harvard University, Department of Chemistry and Chemical Biology, Cambridge, MA.

**9:45 AM BREAK**

**10:15 AM \*LL3.4**

PRINTING TECHNIQUES IN ORGANIC-BASED PHOTONICS AND PHOTOVOLTAICS. Ghassan E. Jabbour, Optical Sciences Center, The University of Arizona, Tucson, AZ.

**10:45 AM LL3.5**

DIRECT-WRITE PROCESS FOR UV-CURABLE EPOXY MATERIALS BY INKJET TECHNOLOGY. Wolfgang Voit, Werner Zapka, XaarJet AB, Jafalla, SWEDEN; and K.V. Rao, Dept of Material Science, Royal Institute of Technology, Stockholm, SWEDEN.

**11:00 AM \*LL3.6**

FABRICATION OF MESOSCALE ENERGY STORAGE SYSTEMS BY LASER DIRECT-WRITE. Craig B. Arnold<sup>a</sup>, Ryan C. Wartena<sup>b</sup>, Karen E. Swider-Lyons<sup>b</sup> and Alberto Piqué<sup>a</sup>; <sup>a</sup>Materials Sciences and Technology Division, Naval Research Laboratory, Washington, DC; <sup>b</sup>Chemistry Division, Naval Research Laboratory, Washington, DC.

**11:30 AM LL3.7**

MEASURED ANISOTROPY OF ALUMINA COMPONENTS PRODUCED BY DIRECT INK-JET PRINTING. Patrick Smith, Brian Derby, Andrew Wallwork, UMIST, Manchester Materials Science Centre, Manchester, UNITED KINGDOM.

**11:45 AM LL3.8**

LASER DIRECT-WRITE OF ALKALINE MICROBATTERIES. Alberto Piqué, Craig B. Arnold, Ryan C. Wartena and Karen E. Swider-Lyons, Naval Research Laboratory, Washington, DC.

SESSION LL4: NANOSCALE RAPID  
PROTOTYPING  
Chair: Alberto Piqué  
Wednesday Afternoon, December 4, 2002  
Gardner (Sheraton)

**1:30 PM \*LL4.1**

MICRO- AND NANO-SCALE TECHNOLOGIES FOR PATTERN AND MATERIAL TRANSFER. David J. Nagel, The George Washington University, Washington, DC.

**2:00 PM \*LL4.2**

DEVELOPMENT OF PARALLEL DIP PEN NANOLITHOGRAPHY (DPN) PROBE ARRAYS FOR HIGH THROUGHPUT NANOLITHOGRAPHY. David Bullen, Xuefeng Wang, Jun Zou, Chang Liu, Micro and Nanotechnology Laboratory, University of Illinois, Urbana, IL; Sung-wook Chung, Chad Mirkin, Northwestern University, Chicago, IL.

**2:30 PM LL4.3**

SITE-SPECIFIC NANOPATTERNING OF FUNCTIONAL MATERIALS. Ming Su, Vinayak Dravid, Northwestern Univ, Dept of Materials Science and Engineering, Evanston, IL.

**2:45 PM LL4.4**

MTU LASER-BASED DIRECT-WRITE TECHNIQUES: RECENT

DEVELOPMENT AND NANOPARTICLES PATTERNING RESULTS. Edward Nadgorny, Changgong Zhou, Department of Physics; Jaroslav Drellich, Juntao Xu, Department of Materials Science and Engineering, and Engineering Research Center for Wireless Integrated Microsystems, Michigan Technological University, Houghton, MI.

**3:00 PM LL4.5**

VERSATILE NANODEPOSITION OF DIELECTRICS AND METALS BY NONCONTACT DIRECT-WRITE TECHNOLOGIES. Heinz D. Wanzenboeck, Helmut Langfischer, Stefan Harasek, Emmerich Bertagnolli, Vienna University of Technology, Institute for Solid State Electronics, Vienna, AUSTRIA.

**3:15 PM \*LL4.6**

TWO-PHOTON LASER MICRO-NANO FABRICATION, UNDERSTANDING FROM SINGLE-VOXEL LEVEL. Satoshi Kawata<sup>a,c</sup> and Hong-Bo Sun<sup>a,b</sup>; <sup>a</sup>Department of Applied Physics, Osaka University, Suita, Osaka, JAPAN; <sup>b</sup>PRESTO, Japan Science and Technology Corporation (JST); <sup>c</sup>The Institute of Physical and Chemical Research (RIKEN), Hirosawa, Wako, Saitama, JAPAN.

SESSION LL5: TISSUE ENGINEERING AND  
BIOMEDICAL APPLICATIONS

Chair: David J. Nagel  
Thursday Morning, December 5, 2002  
Gardner (Sheraton)

**8:30 AM \*LL5.1**

BONE TISSUE SCAFFOLDS TECHNOLOGIES BASED ON RP-ADOPTED DROPLET ASSEMBLY. Yongnian Yan, Renji Zhang, Feng Lin and Zhuo Xiong, Dept. of Mechanical Engineering, Tsinghua University, Beijing, P.R. CHINA.

**9:00 AM LL5.2**

RECONSTRUCTION OF TISSUE SCAFFOLD INTERNAL ARCHITECTURE USING X-RAY MICROFOCUS TOMOGRAPHY. Patrick Smith, Paul Mummery, Brian Derby, Manchester Materials Science Centre, UMIST and University of Manchester, Manchester, UNITED KINGDOM; Eleftherios Sachlos, Jan Czernuszka, Dept of Materials, University of Oxford, Oxford, UNITED KINGDOM.

**9:15 AM LL5.3**

A PROCESS TO MAKE COLLAGEN SCAFFOLDS WITH AN ARTIFICIAL CIRCULATORY SYSTEM USING RAPID PROTOTYPING. E. Sachlos<sup>a</sup>, N. Reis<sup>a,b</sup>, C. Ainsley<sup>b</sup>, B. Derby<sup>b</sup>, J.T. Czernuszka<sup>a</sup>; <sup>a</sup>Department of Materials, University of Oxford, Oxford, UNITED KINGDOM; <sup>b</sup>Manchester Materials Science Centre, UMIST and University of Manchester, Manchester, UNITED KINGDOM.

**9:30 AM \*LL5.4**

SCANNING MULTIPLEXED RAMAN DETECTION OF DNA, RNA, AND PROTEIN TARGETS WITH NANOPARTICLE PROBES. Chad A. Mirkin, Dept. of Chemistry and Institute for Nanotechnology, Northwestern University, Evanston, IL.

**10:00 AM BREAK**

**10:30 AM \*LL5.5**

RAPID PROTOTYPING OF LIVING BIOLOGICAL SYSTEMS. Douglas B. Chrisey, B.R. Ringeisen, D.A. Krizman, H. Kim, and B.J. Spargo, Naval Research Laboratory Washington, DC.

**11:00 AM \*LL5.6**

BIOCHEMICAL IC CHIPS FABRICATED BY HYBRID MICROSTEREOLITHOGRAPHY. Koji Ikuta, Atsushi Takahashi, Kota Ikeda, Shoji Maruo, Department of Micro System Engineering, School of Engineering, Nagoya University, Nagoya, JAPAN.

**11:30 AM LL5.7**

COMPUTATIONAL DESIGN, FREEFORM FABRICATION AND TESTING OF NYLON-6 TISSUE ENGINEERING SCAFFOLDS. Karlin Bark, Krishnan Ramaswamy, Cindy Chen, Adebisi Adewunmi, Daniel Rose, Suman Das, Univ. of Michigan, Mechanical Engineering Dept, Ann Arbor, MI; Scott Hollister, Univ. of Michigan, Biomedical Engineering Dept, Ann Arbor, MI.