

# SYMPOSIUM KK

Femto and Attosecond Phenomena in Materials

December 1 – 3, 2002

## Chairs

S. K. Sundaram Pacific Northwest Natl Laboratory  
Eric Mazur Harvard Univ  
Francois Y. Genin Lawrence Livermore National Laboratory  
Michael J. Stuke Max Planck Inst for Biophysic Chemie

\* Invited paper

## TUTORIAL

### FT KK: FEMTOSECOND TECHNIQUES FOR MATERIALS SCIENTISTS

Sunday, December 1, 2002

1:00 p.m. - 5:00 p.m.

Room 205 (Hynes)

The tutorial starts at a basic level so that everyone begins on solid ground, then quickly advances to state-of-the-art femtosecond techniques. The first part of the tutorial deals with the interaction of light with matter and, after refreshing some basic concepts of electromagnetism, moves on to nonlinear optical processes that are relevant for the propagation of femtosecond laser pulses. The second part deals with measurement techniques.

Some of the tutorial will be taught in an interactive format. The participants will work through a number of problems in small groups using worksheets designed to elicit common misconceptions and lead the participants to the right approach. The subjects for which worksheets will be used are marked by a star (\*) in the outline below.

- Linear and nonlinear propagation of light (1hr. 30 min.)
  - Propagation of electromagnetic waves in dense media
  - Dielectric function
  - Lorentz equations, Drude model
  - Pulse dispersion
  - Nonlinear response
  - Second harmonic generation and inversion symmetry (\*)
  - Self-phase modulation and self focusing
  - Continuum generation applications
- Femtosecond measurements (2hr. 30 min.)
  - Pump-probe technique
  - Dispersion compensation techniques (\*)
  - Representation of pulses; Wigner representation
  - Temporal characterization of pulses
  - Joint time-frequency measurements (\*)
  - Frequency-resolved optical gating
  - Limits of frequency and time resolution (\*)

#### Instructor:

Eric Mazur, Harvard University

### SESSION KK1: ATTOSECOND/FEMTOSECOND PULSES — GENERATION AND APPLICATIONS

Chairs: Eric Mazur and S. K. Sundaram

Monday Morning, December 2, 2002

Berkeley (Sheraton)

## NOTE EARLY START

### 8:15 AM \*KK1.1

ATTOSECOND METROLOGY: LOOKING INTO ATOMS.

Ferenc Krausz, Vienna Univ. Technology, Photonics Inst., Wien, AUSTRIA.

### 8:45 AM \*KK1.2

PROBING THE MOTION OF MATTER WITH LASERS AND

X-RAYS. Melanie Saes, Christian Bressler, Majed Chergui, Universite de Lausanne, Inst. de Physique de la Matiere Condensee, Lausanne-Dorigny, SWITZERLAND; Daniel Grolimund and Rafael Abela, Swiss Light Source, PSI-Villigen, SWITZERLAND; Steve Johnson, Dpt of Physics, UC-Berkeley, Berkeley, CA; Phil Heimann, LBL, Berkeley, CA.

### 9:15 AM \*KK1.3

PHASE COHERENT SYNTHESIS AND CONTROL OF LIGHT.

Jun Ye, JILA National Institute of Standards and Technology and University of Colorado, Boulder, CO.

## 9:45 AM BREAK

### 10:15 AM \*KK1.4

GENERATION AND CHARACTERIZATION OF ULTRA SHORT

XUV PULSES. D. Charalambidis, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE and Department of Physics, University of Crete; N.A. Papadogiannis, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE and Department of Physics, University of Crete; L.A.A. Nikolopoulos, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE; G. Nersysian, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE; E. Hertz, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE; E. Goulielmakis, Foundation for Research and Technology-Hellas, Institute of Electronic Structure & Laser, Laser and Applications Division, Heraklion, GREECE and Department of Physics, University of Crete; G. Tsakiris, Max-Planck-Institut für Quantenoptik, Garching, GERMANY; K. Witte, Max-Planck-Institut für Quantenoptik, Garching, GERMANY.

### 10:45 AM \*KK1.5

ATTOSECOND SCIENCE. P.B. Corkum, J. Itatani, F. Quere, H. Niikura, F. Legare, R. Hasbani, M. Yu Ivanov and D.M. Villeneuve, National Research Council of Canada, Steacie Institute for Molecular Sciences, Ottawa, Ontario, CANADA.

### 11:15 AM \*KK1.6

HIGH-QUALITY FEW-CYCLE LASER PULSE GENERATION, CHARACTERIZATION AND APPLICATION TO ULTRAFAST SPECTROSCOPY. Jianying Zhou, State Key Laboratory of Optoelectronic Material and Technology, Zhongshan University, Guangzhou, CHINA and Department of Physics, Fudan University, Shanghai, CHINA; Y.J. Yan, Department of Chemistry, Hong Kong University of Science and Technology, HONG KONG; C.J. Zhu, J. Kuhl, Max-Planck-Institut für Festkoerperforschung, Stuttgart, GERMANY.

## SESSION KK2: IN-ROOM POSTER SESSION

Chairs: Eric Mazur and S. K. Sundaram

Monday Morning, December 2, 2002

11:00 AM

Berkeley (Sheraton)

### KK2.1

TIME-DOMAIN STUDY OF COHERENT SOFT MODES IN GeTe FERROELECTRICS USING HIGH DENSITY

PHOTOEXCITATION. Muneaki Hase, Masahiro Kitajima, Mat. Eng. Lab., Natl. Inst. Mater. Sci., Tsukuba, JAPAN; Shin-ichi Nakashima, Power Electron. Res. Center, Natl. Inst. of Adv. Indus. Sci. and Tech., Tsukuba, JAPAN; Kohji Mizoguchi, Dept. of Appl. Phys., Osaka City Univ., Osaka, JAPAN.

### KK2.2

COMPUTATIONAL MODEL FOR ATOMISTIC SIMULATION OF ULTRASHORT LASER PULSE INTERACTIONS WITH METALS.

Dmitri Ivanov, Leonid V. Zhigilei, University of Virginia, Department of Materials Science and Engineering, Charlottesville, VA.

SESSION KK3: SEMICONDUCTORS  
Chairs: Michael J. Stuke and Francois Y. Genin  
Monday Afternoon, December 2, 2002  
Berkeley (Sheraton)

**1:30 PM \*KK3.1**

ULTRAFAST INTERSUBBAND COHERENCES IN SEMICONDUCTOR QUANTUM WELLS AND QUANTUM CASCADE STRUCTURES. T. Elsaesser, R.A. Kaindl, F. Eickemeyer, K. Reimann, M. Woerner, Max-Born-Institute, Berlin, GERMANY; S. Barbieri, C. Sirtori, Thales-CSF, Orsay, FRANCE; G. Strasser, T. Müller, R. Bratschitsch, K. Unterrainer, Technical University, Inst. for Solid State Electronics, Vienna, AUSTRIA; R. Hey, K.H. Ploog, Paul-Drude-Institute, Berlin, GERMANY.

**2:00 PM KK3.2**

PHOTOEXCITATIONS IN BULK AND SURFACE SILICON. B.R. Torralva and P.E.A. Turchi, Lawrence Livermore National Laboratory, Department of Chemistry and Materials Science, Livermore, CA.

**2:15 PM KK3.3**

DAMAGE INDUCED BY FEMTOSECOND MICROMACHINING OF Si. S.M. Yalisove, Y.N. Picard, E.C.M. Carroll, J.F. Mansfield, University of Michigan, Dept. of Mat. Sci. & Eng., Ann Arbor, MI; and P.P. Pronko, University of Michigan, Center for Ultrafast Optical Sciences, Ann Arbor, MI.

**2:30 PM KK3.4**

EARLY STAGES OF FEMTOSECOND-LASER-INDUCED FORMATION OF SILICON MICROSPIKES. Catherine H. Crouch, Mengyan Shen, James E. Carey, and Eric Mazur, Harvard University, Cambridge, MA.

**2:45 PM KK3.5**

COMPARING FEMTOSECOND AND NANOSECOND LASER STRUCTURING OF SILICON: PROPERTIES AND MICROCONE STRUCTURE. Catherine H. Crouch, James E. Carey, Jeff Warrener, Michael J. Aziz, and Eric Mazur, Harvard University, Cambridge, MA.

**3:00 PM BREAK**

SESSION KK4: MODELING

Chairs: Michael J. Stuke and Francois Y. Genin  
Monday Afternoon, December 2, 2002  
Berkeley (Sheraton)

**3:30 PM \*KK4.1**

MOLECULAR DYNAMICS SIMULATIONS OF LASER INTERACTIONS WITH ORGANIC MATERIALS AND METALS. Leonid V. Zhigilei, Dmitri Ivanov, Elodie Leveugle, University of Virginia, Department of Materials Science & Engineering, Charlottesville, VA.

SESSION KK5: MICROMACHINING

Chairs: Peter P. Pronko and Catherine H. Crouch  
Tuesday Morning, December 3, 2002  
Berkeley (Sheraton)

**8:30 AM \*KK5.1**

THE ROLE OF MICROSTRUCTURING FOR DISPERSION COMPENSATION IN FEMTOSECOND OPTICS. Günter Steinmeyer, Swiss Federal Institute of Technology, Zurich, SWITZERLAND.

**9:00 AM KK5.2**

SUB-DIFFRACTION LIMIT MACHINING WITH FEMTOSECOND LASER. David Jen Hwang, Taeyul Choi, Costas P. Grigoropoulos, Univ of California Berkeley, Dept of Mechanical Engineering, Berkeley, CA.

**9:15 AM KK5.3**

WRITING OF VOLUME HOLOGRAM IN SILICA GLASS BY A SINGLE CHIRPED LASER PULSE. Ken-ichi Kawamura, Masahiro Hirano, Toshio Kamiya and Hideo Hosono, Hosono Transparent Electro-Active Materials (TEAM) Project, Exploratory Research for Advanced Technology (ERATO), Japan Science and Technology, Kanagawa, JAPAN.

**9:30 AM KK5.4**

LASER WRITING AND CHARACTERIZATION OF STRUCTURES IN A CHALCOGENIDE GLASS. S.K. Sundaram, Bradley R.

Johnson, Paul J. Allen, Norman C. Anheier Jr., Richard M. Williams, John F. Schultz, Pacific Northwest National Laboratory, Richland, WA.

**9:45 AM BREAK**

**10:15 AM KK5.5**

FEMTOSECOND LASER WRITING IN LASER GLASSES. S. K. Sundaram, Pacific Northwest National Laboratory, Richland, WA; J. Ashcom, Rafael R. Gattass, Eric Mazur, Harvard University, Cambridge, MA.

**10:30 AM KK5.6**

AN OPTICAL BANDPASS FILTER FABRICATED BY AN ULTRAFAST LASER. Ming Li, Kiyotaka Mori, Makoto Ishizuka, and Xinbing Liu, Panasonic Boston Laboratory, Cambridge, MA; Yoshimasa Sugimoto, Naoki Ikeda, and Kiyoshi Asakawa, The Femtosecond Technology Research Association, Tsukuba, JAPAN.

SESSION KK6: BIOMEDICAL AND LIVING CELLS

Chairs: Peter P. Pronko and Catherine H. Crouch  
Tuesday Morning, December 3, 2002  
Berkeley (Sheraton)

**10:45 AM \*KK6.1**

ABLATION PROCESSING OF ADVANCED AND BIOMEDICAL MATERIALS BY TAILORED FEMTOSECOND LASER PULSE. Kazue Ozono, Minoru Obara, Department of Electronics and Electrical Engineering, Keio University, Yokohama, JAPAN.

**11:15 AM \*KK6.2**

FEMTOSECOND LASER MICROSURGERY AND TWO-PHOTON IMAGING OF LIVE SINGLE CELLS. Adela Ben-Yakar, Stanford University, Applied Physics Department, Stanford, CA; Nan Shen and Eric Mazur, Harvard University, Division of Engineering & Applied Sciences, Cambridge, MA.

SESSION KK7: IN-ROOM POSTER SESSION

Chairs: Peter P. Pronko and Catherine H. Crouch  
Tuesday Morning, December 3, 2002  
11:00 AM  
Berkeley (Sheraton)

**KK7.1**

FEMTOSECOND LASER PULSE INDUCED REFRACTIVE INDEX CHANGES IN GLASSES. Pin Yang, David R. Tallant, George R. Burns, Michelle Griffith, Sandia National Laboratories, Albuquerque, NM.

**KK7.2**

PHOTOMECHANICAL EFFECTS IN SHORT-PULSE LASER ABLATION: SUB-SURFACE VOID NUCLEATION AND GROWTH. Elodie Leveugle, Leonid Zhigilei, University of Virginia, Charlottesville, VA.

**KK7.3**

PHOTON ECHO STUDIES OF ELECTRONIC PROPERTIES OF MEH-PPV CONJUGATED POLYMER. Xiujuan Yang, Vitalij Kovalskij, Gregory D. Scholes, Lash-Miller Chemical Laboratories, University of Toronto, Ontario, CANADA.

SESSION KK8: LASER-MATERIAL INTERACTIONS AND PROCESSING

Chairs: Francois Y. Genin and S. K. Sundaram  
Tuesday Afternoon, December 3, 2002  
Berkeley (Sheraton)

**1:30 PM \*KK8.1**

PLASMAS AND PLUMES: TIME-RESOLVED DETECTION OF ULTRAFAST LASER-MATERIAL INTERACTIONS. Samuel S. Mao, X.L. Mao, R.E. Russo, Lawrence Berkeley National Laboratory, Berkeley, CA.

**2:00 PM KK8.2**

WAVELENGTH-SELECTIVE, PICOSECOND-LASER-ASSISTED CHEMICAL VAPOR DEPOSITION OF CUBIC BN. B. Ivanov, R.F. Haglund Jr., Department of Physics and Astronomy, Vanderbilt University, Nashville, TN.

**2:15 PM KK8.3**

RESONANT INFRARED PULSED LASER DEPOSITION OF POLYMERS USING PICOSECOND AND NANOSECOND PULSES. D.M. Bubb, Seton Hall University, Dept of Physics, South Orange, NJ; M.R. Papantonakis and R.F. Haglund Jr., Vanderbilt University, Dept of Physics and Astronomy, Nashville, TN; J.S. Horwitz and E.J. Houser, Naval Research Laboratory, Washington, DC.

**2:30 PM KK8.4**

OPTOTHERMAL TRANSCENDENCE SIGNALS OF SiC MATERIALS USING COHERENT FEMTOSECOND PULSES. Yoshiaki Takata, Hajime Haneda, Yoshiki Wada, Takefumi Mitsuhashi, Advanced Materials Laboratory, NIMS, Tsukuba, JAPAN.

**2:45 PM BREAK**

SESSION KK9: NANOMATERIALS  
Chairs: Francois Y. Genin and S. K. Sundaram  
Tuesday Afternoon, December 3, 2002  
Berkeley (Sheraton)

**3:15 PM \*KK9.1**

CONTROLLED SUB-MICRON CLUSTER FORMATION BY FEMTOSECOND LASER-PULSE ABSORPTION IN ULTRAFAST ABLATION PLASMAS. Zhiyu Zhang, Peter Pronko, University of Michigan, Center for Ultrafast Optical Science and Dept of Electrical Engineering and Computer Science, Ann Arbor, MI; Lisa Friedman, Princeton Univ, Dept of Electrical Engineering, Princeton, NJ.

**3:45 PM KK9.2**

FEMTOSECOND LASER AND SCANNING PROBE MICROSCOPE BASED NANOSTRUCTURING. Anant Chimmalgi, Taeyul Choi, Costas P. Grigoropoulos, University of California Berkeley, Dept of Mechanical Engineering, Berkeley, CA.

**4:00 PM KK9.3**

OPTICAL AND ACOUSTIC CHARACTERIZATION OF LASER-INDUCED OPTICAL BREAKDOWN AND ITS ENHANCEMENT BY METAL/DENDRIMER NANOCOMPOSITES. Lajos Balogh, Jing Yong Ye, Theodore B. Norris, James Baker Jr., Susanne Milas, Kyle Hollman, Stanislav Emelianov, Matthew O'Donnell, University of Michigan, Ann Arbor, MI.

**4:15 PM KK9.4**

NANOISLAND NUCLEATION IN THERMAL SPIKES AT SURFACES IRRADIATED WITH SWIFT HEAVY IONS AND FS LASER PULSES. Alexander E. Volkov and Michael V. Sorokin, Institute of General and Nuclear Physics, Russian Research Centre Kurchatov Institute, Moscow, RUSSIA.