

**4-th International Symposium on Ultrafast Surface Dynamics  
Telluride, Colorado (Telluride Summer Research Center)  
June 22-27, 2003**

The 4-th International Symposium on Ultrafast Surface Dynamics (UDS4) was held at the Telluride Summer Research Center on June 22-27, 2003. The International Organizing Committee consisting of Hrvoje Petek (USA), Xiaoyang Zhu (USA), Pedro Echenique (Spain) and Maki Kawai (Japan) brought together a total of 51 participants 16 of whom were from Europe, 10 from Japan, and 25 from the USA. The focus of the conference was on the dynamics of elementary excitations, mainly electrons and phonons, at or near metal and semiconductor interfaces. In particular, we explored the relaxation processes of the intrinsic electronic excitations at essentially perfect surfaces, as well as surfaces that have been modified by molecular or atomic adsorption under well-defined conditions.

The program consisted of eight sessions focusing on molecule-metal interfaces, single molecules and devices, molecular electronics, spins and plasmons, surface & bulk states, image states & dynamics, phonons & excitons, and femtosecond surface chemistry. Each session involved two to three invited talks and as many contributed talks. There was significant time left for discussion after the talks and during the breaks to provide the opportunity for questions and informal exchange of information. In addition, there was a poster session to provide an opportunity for graduate students and postdocs to present their latest research. The best poster award was won by Dr. Niko Pontius of the University of Pittsburgh for his PhD research at the Forschungszentrum Jülich GmbH.

The organizers made an effort to foster interaction between researchers who are focused on the fundamental dynamical processes at interfaces and those that are exploring more complex phenomena, for instance, the conductivity through single molecules and ultrafast magnetism. These more complex phenomena can now be approached from the perspective of fundamental processes that can be explored by ultrafast laser techniques and *ab initio* theory. One of the goals of the organizers has been to bring these highly specialized groups of researchers together in order to broaden their perspectives.

In addition to the scientific sessions, in the spirit of previous Symposia, the organizers set aside significant time for informal discussion starting with the reception at the Telluride Mountain Lodge. The reception was held outside giving the participants a panoramic view of Sangre de Cristo Mountains. On Wednesday most of the day was reserved for an organized hike that took the participants into the mountains up to a waterfall, and afterwards the group split up into subgroups that either retraced their steps or went on further to conquer 4000 m high peaks. The hike was capped by a barbeque that was organized by the Telluride Science Research Center on a mesa outside of Telluride, with panoramic view of the mountains. Finally, on Thursday we had a formal banquet in one of the local restaurants in Telluride.

The workshop was deemed a great success and the International Steering Committee decided to organize the next Symposium on related topics in three years on May 21-25, 2006 in Abashiri, Hokkaido, Japan (<http://www.nims.go.jp/ldynamics/USD/>).

The DOE funds were expanded for partial travel support split equally between Invited speakers and young scientists (graduate students). The support was provided for Mr. Bin Li (University of Pittsburgh), Mr. Vahit Sametoglu (University of Pittsburgh), Ms. A. Monia Constantinescu (University of Pittsburgh), Prof. Supriyo Data (Purdue University), Prof. Mark Ratner (Northwestern University), Prof. Tamar Seideman (Northwestern University), Mr. Chi-Fong Lei (University of Colorado), Mr. Xiaohui Qui (University of California (Irvine)), Prof. Paul Weiss, Mr. Chad Lindstrom (University of Minnesota), Prof. Tony Heinz (Columbia University), and Prof. Charles B. Harris (University of California, Berkeley).

Due to the strong interest in the Symposium, the organizers were able to attract support from other agencies and companies other than DOE including Donostia International Physics Center, IUVSTA – International Union for Vacuum Science Technique and Applications, Petroleum Research Fund, Spectra Physics, Coherent, Clark Instruments, Specs Scientific Instruments, Femtolasers, Positive Light, Omicron, and RHK.

The conference program attached below summarizes the topics covered and the list of presenters at the Symposium.

## **Final program**

### **MONDAY, June 23**

#### **Session 1: Molecule-metal interfaces**

Chair - Hrvoje Petek (University of Pittsburgh)

8:30 - 8:40 - "Opening remarks"

Hrvoje Petek (University of Pittsburgh) & Xiaoyang Zhu (University of Minnesota)

8:40 - 9:30 am - "Electron solvation and localization in two dimensions"

Charles Harris (University of California-Berkeley, USA)

9:30 - 10:20 am - "Ultrafast dynamics of electron transfer, localization and solvation at the adsorbate/metal interface"

Martin Wolf (Free University, Berlin, Germany)

10:20 - 10:40 am "Coffee Break"

10:40 - 11:30 am - "Electronic interaction at molecule-metal interfaces: implication for molecule-based electronics"

Xiaoyang Zhu (University of Minnesota, USA)

11:30 - 11:50 am - "Real-time atomistic simulation of the ultrafast photoinduced electron transfer from molecular donors to the TiO<sub>2</sub> acceptor"

Oleg Prezhdo (University of Washington, USA)

11:50 am - 12:10 pm - "Electron Transfer as a Unifying Theme: Quantum Confined (Vibrational) Mirages in STM, as a current example"  
J. W. Gadzuk (NIST, USA)

LUNCH break

## **Session 2: Single Molecules and Devices**

Chair - Mark Ratner (Northwestern University, USA)

1:30 - 2:20 pm - "Manipulating Individual Molecules via Vibrational Excitation: Reaction and Spectroscopy"  
Maki Kawai (RIKEN, Japan)

2:20 - 3:10 pm - "Vibrationally resolved fluorescence excited with submolecular precision"  
Xiaohui Qiu (University of California-Irvine, USA)

3:10 - 3:30 pm - "Coffee break"

3:30- 4:20 pm - "Current-triggered dynamics in molecular-scale devices"  
Tamar Seideman (Northwestern University)

4:20 - 5:10 pm - "Single molecule devices and dynamics"  
Paul Weiss (Penn State University, USA)

## **TUESDAY, June 24**

### **Session 3: Molecular electronics**

Chair - Xiaoyang Zhu (University of Minnesota)

8:30 - 9:20 am - "Molecular devices and circuits"  
Supriyo Datta (Purdue University, USA)

9:20 - 10:10 am - "Understanding charge transport in molecular electronics"  
James Kushmerick (Naval Research Lab, USA)

10:10 - 10:30 am - "Coffee break"

10:30- 11:20 am - "Molecular transport devices: interconnects and slightly beyond"  
Mark Ratner (Northwestern University, USA)

11:20 - 12:10 am - "Contact effects in molecular junctions"  
Daniel Frisbie (University of Minnesota, USA)

LUNCH BREAK

#### **Session 4: Spins and Plasmons**

Chair - Tony Heinz (Columbia University, USA)

1:30 - 2:20 pm - "Time-resolved spin-wave spectroscopy"

Paul Crowell (University of Minnesota, USA)

2:20 - 3:10 pm - "Dynamic domain pattern formation in mesoscopic nonequilibrium ferromagnets"

Mark Freeman (University of Alberta, Canada)

3:10 - 3:30 pm - "Coupled coherent optical phonons and magnons excited via the exchange split Gd(0001) surface state"

A. Melnikov (Freie Universität Berlin, Berlin, Germany)

3:30 - 3:40 pm - "Coffee break"

3:40 - 4:30 pm - "Ultrafast magnetization dynamics of metallic ferromagnetic materials"

L. Guidoni, E. Beaurepaire and J.-Y. Bigot (Laboratoire IPCMS, CNRS-ULP, Strasbourg, FRANCE)

4:30 - 5:20 am - "Low energy collective electronic excitations at metal surfaces"

P. Echenique (Donostia International Physics Center, San Sebastian, Spain)

#### **Session 5: Wine & Posters (Sponsored by Femtolasers)**

Chairs & best student poster selection committee (Bonn, Seideman, Willig)

5:30- 7:00 pm

"New developments in femtosecond light sources"

A. Fürbach, T. Le, M. Hentschel, A. Baltuska, A. Unterhuber (Femtolasers Produktions GmbH; Photonics Institute, Vienna University of Technology; Institut of Medical Physics, Christian Doppler Laboratory, Vienna University of Technology, Austria)

"Femtosecond Time-Resolved Two-Photon Photoemission Studies of Electron Dynamics on Ag(111) Surface"

Vahit Sametoglu, Ken Onda, Atsushi Kubo, and Hrvoje Petek, (University of Pittsburgh, USA)

"Coherent electro-optic response of semiconductor surfaces"

Anca-Monia Constantinescu and Hrvoje Petek (Univ. of Pittsburgh, USA); Muneaki Hase and Masahiro Kitajima, (National Institute for Materials Science, Japan)

"Time-resolved two-photon photoemission spectroscopy of stoichiometric and modified TiO<sub>2</sub> (110) surfaces"

Bin Li, Ken Onda, Hrvoje Petek (Univ. of Pittsburgh, USA)

"Ultrafast energy dissipation in small optically excited transition metal clusters and metal cluster-adsorbate systems"

N. Pontius\*, M. Neeb, W. Eberhardt, *BESSY GmbH, Albert-Einstein-Strasse 15, 12489 Berlin, Germany*

G. Lüttgens, P. S. Bechthold, *Forschungszentrum Jülich GmbH, IFF, 52425 Jülich, Germany*

"Electronic structure of organic film at sub-micrometer surface area"

T. Munakata, T. Masuda and T. Sugiyama (RIKEN, Japan)

"Lattice dynamics of graphite under high density photo-excitation"

Kunie Ishioka, Muneaki Hase and Masahiro Kitajima (National Institute for Materials, Japan)

"Photoemission studies of organic-thiol self-assembled monolayers on gold surfaces"

CD Zangmeister, SW Robey, and RD van Zee (NIST, USA)

"Hg-Alkanethiol//Arenethiol-Au Bilayer Molecular Junctions"

John Le, Yan He\*, Curtis Mead, Thomas R. Hoyer\* and Richard A. Kiehl (*University of Minnesota, USA*)

"Hot electron transfer at organic-metal interface: Photodissociation of phenol on Ag(111)"

Sunmin Ryu, Jinyoung Chang, Junseok Lee, and Seong Keun Kim (Seoul National University)

"Dynamics of H atom abstraction of adsorbed D on Si(100)"

Atsushi Kubo, Jiri Drbohlav, Yasuhiro Ishii, and Masahiro Kitajima (National Institute for Materials Science and University of Tsukuba, Japan)

"Ultrafast exciton relaxation dynamics in C60"

Gregory Dutton, X.-Y. Zhu (University of Minnesota, USA)

"Electron dynamics at pentacene/Au interfaces"

Chad Lindstrom, Samuel Nitzkowski, Joo H. Kang, X.-Y. Zhu (University of Minnesota, USA)

"Microscopic Mechanisms of Energy Relaxation and Dephasing at Metal Surfaces"

Mamoru Sakaue <sup>1</sup>, Toshiaki Munakata <sup>1</sup>, Hideaki Kasai <sup>2</sup> and Ayao Okiji <sup>3</sup>  
<sup>1</sup> RIKEN, <sup>2</sup> Osaka University, <sup>3</sup> Wakayama National College of Technology, Japan

"On the Detection of Chemically-Induced Hot Electrons in Surface Processes: from X-ray Edges to Schottky Barriers"

J. W. Gadzuk (NIST, USA)

"Light-induced heterogeneous electron transfer probed with photoemission signals: Chemically anchored perylene on rutile TiO<sub>2</sub>(110)" L. Gundlach, R. Ernstorfer, S. Felber, E. Galoppini, Q. Wei, L. Töben, R. Eichberger, S. Ramakrishna, and F. Willig (Hahn-Meitner-Institut, Germany; Rutgers University, USA)

"Femtosecond nanoparticle-substrate interaction of surface-passivated metallic nanoparticles on graphite substrates"  
Akinori Tanaka, Yuitsu Takeda, Masaki Imamura, and Shigeru Sato (Tohoku University, Japan)

## **WEDNESDAY, June 25**

### **Session 6: Surface & bulk states**

Chair - P. Echenique (Donostia International Physics Center, San Sebastian, Spain)

8:30 - 9:20 pm - "Electron and hole dynamics in surface and quantum-well states on metal surfaces"

E. Chulkov (San Sebastian University, Spain)

9:20 - 9:40 am - "Unoccupied electronic states of high-temperature superconductor Bi<sub>2</sub>212 measured with two-photon photoemission"

T. Munakata and Y. Sonoda (RIKEN, Japan)

9:40 - 10:00 am - "Femtosecond electron transfer from the C1-surface state into bulk states of In-rich (2x4)-reconstructed InP(100)"

Frank Willig (Hahn-Meitner-Institute, Berlin, Germany)

### **Session 7: Hiking, BBQ, & free discussions**

Chair - Branko Gumhalter (University of Zagreb, Croatia)

10:20 am - 6 pm

## **THURSDAY, June 26**

### **Session 8: Image states & dynamics**

Chair - Martin Wolf (Free University, Berlin, Germany)

9:00 - 9:50 am - "Time-resolved two-photon photoemission of Ar/Cu-interface states"

U. Hoyer (University Marburg, Germany)

9:50 - 10:40 am - "Scattering processes in image-potential bands at metal surfaces"

Th. Fauster (University Erlangen, Germany)

10:40 - 11:00 am - "Coffee break"

11:00 - 11:50 am - "Femtosecond decoherence of quasiparticles in the states of image potential: beyond the lifetime effects given by fermi's golden rule"

Branko Gumhalter (University of Zagreb, Croatia)

LUNCH break

### **Session 9: Phonons & Excitons**

Chair - Micha Asscher (Hebrew University, Israel)

1:30 - 2:20 pm- "Ultrafast interference of coherent optical phonons with electron-hole pair excitations in photoexcited Si"

M. Hase (National Institute for Materials Science, Tsukuba, Japan)

2:20 - 3:10 pm- "Coherent surface phonon dynamics on a Cs-covered Pt(111) surface studied by time-resolved second harmonic generation"

Yoshiyasu Matsumoto, (The Graduate Univ. for Advanced Studies, Japan)

3:10 - 3:30 pm- "Coffee break"

3:30 - 4:20 pm- "Surface exciton formation on Si(100)"

Martin Weinelt (University Erlangen, Germany)

4:20 - 5:10 pm- "Electron-phonon interactions probed by time-resolved photoemission"

Tobias Hertel (Fritz-Haber-Institute, Germany)

5:10 - 5:30 pm- "Probing adsorbate oscillation on metal surfaces using ultrafast extreme ultraviolet pulses"

Chi-Fong Lei (JILA & University of Colorado, USA)

6:00 - 9:00 pm **Banquet (Sponsored by Spectra Physics)**

## **FRIDAY, June 27**

### **Session 10: Femtosecond Surface Chemistry**

Chair - Yoshiyasu Matsumoto (The Graduate Univ. for Advanced Studies, Japan)

8:30 - 9:20 am - "Observing and controlling of atomic motion on metal surfaces with femtosecond and sub-angstrom resolution"

H. Petek (University Pittsburgh, USA)

9:20 - 10:10 am - "Isotope effect in femtosecond laser induced desorption"

T.F. Heinz (Columbia University, USA)

10:10 - 10:30 am "Coffee break"

10:30 - 11:20 am - "Femtosecond laser-induced desorption and reaction of NO and CO on Pt(533)"

Mischa Bonn (Leiden Institute of Chemistry, Netherlands)

11:20 - 11:40 am - "Electronic excitation and dynamic promotion of a surface reaction"

C. Frischkorn (Freie Universität Berlin, Germany)

11:40 am- 12:00 pm - "Photochemistry of oriented and caged molecules"

Micha Asscher (Hebrew University, Israel)

**Concluding remarks and announcements for the 5th USD symposium**