Welcome to the Summer School on Techniques of Surface Science and Catalysis

Santa Barbara, Aug. 13-26 2006

Jointly sponsored by the

Partnership for International Research and Education and

The International Center for Materials Research.



Some highlights of the coming two weeks.

A bit about the PIRE-ECCI

A perspective on China based on some facts and figures

International partnerships between scientists

## Highlights of the coming two weeks

- Scientific and business presentations and panel discussions
- UCSB campus tour
- MCC event to get to know one another
- Karaoke Night
- Weekend
  - Soccer Game
  - Wine Tours
  - Hikes
  - Trip To LA China Town
- Poster Session
- Group Dinner in SB at El Paseo Restaurant
- Group Farewell Barbeque on final Friday



Join us!

PROSPECTIVE GRADUATE STUDENTS:

www.pire-ecci.ucsb.edu

ications to the PIRE-ECCI graduate rogram from all academically-qualified dividuals are encouraged. Inquiries and pplication materials can be sent electronically at any time to: secretary.pire-ecci@chem.ucsb.edu

#### Dalian, CHINA Santa Barbara, CA

MISSION: The goal of the PIRE-ECCI is to contribute to the training a new generation of Ph.D.'s. with extraordinary technical abilities and a global experience of interdisciplinary research. The PIRE-ECCI program provides graduate students in Chemistry, Chemical Engineering, Materials and Physics with the opportunity to experience China first-hand while participating in forefront research, create personal networks of friends and associates, and grow into academic and industrial leaders on the scientific and technical global landscape.

#### Two premier research institutions







Susannah SCOTT

Catalyst Design

and Fabrication

connections between surface chemical dynamics and catalytic phenomena.



EXTENDED RESEARCH VISITS The central component of the educational program will be Extended Research Visits (XRVs) to Dalian by UCSB graduate students in science and engineering, as they pursue collaborative research projects co-mentored by UCSB and DICP faculty.

An ambitious education program

In 2006: "Techniques of Surface Science and Catalysis" In 2008: "Grand Challenges for Chemical Dynamics in Heterogeneous Catalysis"



DALIAN WORKSHOPS ON FLECTRON CHEMISTRY AND CATALYSIS In 2007 and 2009, all PIRE-ECCI participants will meet in Dalian, China for a 4day workshop to share results, bolster collaborations and explore new directions

CHINESE TECHNOLOGY-TRANSFER STUDY TOURS The tours will involve visits to companies with headquarters or major branch locations in China that are involved with international technology transfer. The CTTTs are modeled after Global Business Study Tours that have been so successful in the world's leading Business Schools. These business and cultural field trips will include personal meetings with executives, company and factory tours, cultural excursions, and social dinners with Chinese colleagues in the private sector. At the close of the 2007 and 2009 Dalian Workshops on Electron Chemistry and Catalysis at Interfaces, a CTTT will be organized for interested participants. The tours will be led by senior graduate students, advised and accompanied by faculty from UCSB's Technology Management Program. Students may earn academic credit through tour participation

We will be inviting local business leaders to pany our students on these trips and serve as ess mentors"

> CHINESE LANGUAGE TRAINING We believe that language proficiency is an essential element of a meaningful intercultural experience. While much of the scientific discussion for students on XRVs will be in English, their social interaction and contact with Chinese culture will be enhanced by a foundation in spoken Mandarin. Language training will be provided by UCSB's East Asian Studies department. Prior to their first XRV in Dalian, students and post-docs will enroll in an intensive 9-week Beginning Chinese language course.



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**UCSB** 







DICP



#### Eric MCEARLAND Surface Chemistry and Chemical Sensors



Horia METIU Theory of Catalytic Mechanisms



Two hallmarks of UCSB research, interdisciplinary collaboration and excellence in materials science, combine with campus expertise to create a unique synergy in modern heterogeneous catalysis research. Spanning fundamental science and engineering, theory and experiment, the team is poised to make new



Steve BURATTO Ion Soft Landing and UHV Scanning Probe Microscopies



Matthias SCHEFFLER

Martin MOSKOVITS

Nano-fabrication and

Optical Characterization

of Interfaces

Electronic structure theory of complex materials

Alec WODTKE Surface Chemical Dynamics











Finding special conditions that speed-up normally slow reactions.

Convert cheap and abundant chemicals into useful, high-value ones.

Convert noxious chemicals to harmless ones

e.g. conversion of  $N_2$  and  $H_2$  to  $NH_3$ 

## "Air to Food": The greatest scientific discovery of the last century

- At moderate temperatures and high pressures, hydrogen and nitrogen (from thin air) will form ammonia.
- Nearly one century after its invention, the process is still applied all over the world to produce 500 million tons of artificial fertilizer per year, <u>sustaining 40% of the worlds</u> <u>population</u> - *Nature 427, p 498, 2004*
- <u>1% of the world's energy budget</u> is used for a single reaction *Science 297(1654) 2002*







## **Closer to Home: Gas-to-Gasoline!!**



Gas Reaction Technologies Inc. in Goleta, CA.
GRT is a UCSB spawned company
Now partnered with "big-oil" to develop 1000 barrel per day

pilot plant

# Modern Catalysis – New opportunities and challenges

- Nano-catalysis nanoscience is providing new in-roads into better ways to carry out catalysis.
  - "Preparation of supported gold catalysts by gas-phase grafting of gold acethylacetonate for low-temperature oxidation of CO and of H<sub>2"</sub>
     Okumura, M., S. Tsubota, and M. Haruta, <u>J. Mol. Catal.</u>, 2003

Photocatalysis - replacing heat by light as an energy source for chemistry.

- Developing a first-principles approach to Catalysis
  - "Optimal Catalyst Curves: Connecting Density Functional Theory Calculations with Industrial Reactor Design and Catalyst Selection" CJH Jacobsen, S Dahl, A Boisen, BS Clausen, H Topsøe, A Logadottir, and <u>IK</u> <u>Nørskov</u> JOURNAL OF CATALYSIS 2002

A fact based perspective on China

## China 100 years ago

Famous French political cartoon from the late <u>1890s</u>.

A shocked <u>mandarin</u> in <u>Manchu</u> robe in the back, with <u>Queen</u> <u>Victoria</u>, <u>Wilhelm II</u>, <u>Nicholas II</u>, <u>Marianne</u>, and <u>Emperor Meiji</u> stabbing into a plate with *Chine* written on it.



## China Today – Already The world's largest consumer

- Already for several key raw materials: Grain, meat, oil, coal, and steel, the US out-consumes China only in OIL
- If China grows its economy at 8% per year, in 2031 its per capita income will equal that of the US in 2004

If China adopts the "American Way of Life" it would then consume

- 99 million barrels of oil per day 120% of present world production
- 2/3 of present world grain harvest
- Paper consumption double the current world production

China would drive 1.1 billion cars, well beyond the current world fleet of 800 million vehicles, and would require China to pave an area equal to its national rice land, its staple crop

## **China's Agricultural Production**

Arable land is 25% less than that of U.S., but China produces 30% more crops and livestock because of intensive cultivation.

China is now among the world's largest producers of rice, corn, wheat, soybeans, vegetables, tea, and pork.

Between 1981 and 2001 the number of people living in poverty in China dropped by <u>~430 million</u>, due to economic growth, population stabilization and increased grain production.

This alone virtually ensures that the 2000 UN goal of cutting poverty by half before 2015 will be reached.

#### In 2005 Food Aid to China was ended

## China controls its population growth

- Along with the US, China has dropped its population growth to close to the replacement level
- Lowering family size and leading to population stability.



## China – Faces challenges of Desertification

The Great Green Wall – 2800 miles long by 60 miles wide band of new Forest from Beijing to Inner Mongolia along the southern edge of the Gobi Desert.

 70 year project at a cost of 6 billion \$US

Presently the World's largest effort to limit desertification.



#### Mongolian dust over Beijing



## China's water management

#### Three Gorges Dam project

- 2.3 km long, 185 m high, World's largest Hydroelectric Dam - five times larger than the Hoover Dam.
- 18.2 GWatts (3 x that of Grand Coulee Dam)
- Downstream flood control, Three massive floods in the Yangtze basin have killed over 320,000 people in recent years – 1998 Floods alone caused 3 Billion \$US damage





## **Ecological Efforts**

Logging Ban imposed in Yangtze River Basin after floods of 1998 caused 3 billion \$US in damage. The Chinese government estimated the economic value of uncut trees to be three times that of cut trees.

Aquaculture - 29 million tons per year of farmed fish (2/3 of global output) from China is now 30% of the worlds ocean catch.

 BTW farmed fish will surpass beef to become the third most important source of animal protein within 5 years, behind pork and poultry.

## **Science Policy**

Scientists are playing a major role in our economic reform and social transformation. It is in this vein that we are encouraging scientists to conduct basic research in fields where the needs of the state intersect the frontiers of science, and we applaud those who are driven by curiosity to pursue pure research. We recognize and respect the unique sensitivities and sensibilities of scientists; we understand that scientific creativity is the very source and lifeline of a knowledge-based economy.

-Jiang Zemin

## **S&T Budgets in Recent years**



## A word about international partnerships

Between scientists...







BUSH · CONDOLEEZZA RICE · DONALD RUMSFELD

REPRISING THEIR ROLES FROM EPISODE I DICK CHENEY · SADDAM HUSSEIN · COLIN POWELL INTRODUCING OSAMA BIN LADEN AS THE PHANTOM MENACE

EORGE W



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### **A Definition of Science**

- "The refinement of techniques for prompt discovery of error serves as well as any other as a hallmark of what we mean by science."
  - ... J. Robert Oppenheimer
- As scientists we have a duty to question our assumptions and those of others.
- You will immediately realize; this makes science a communal activity.

## **Question Authority**

"We think of the questions we have today to which we have no answer and to which you will come to know an answer. But even more, we think of the answers we have today and of the new questions that you will put to those answers!"

... J. Robert Oppenheimer speaking to a group of young science graduates

## Honor opposing viewpoints

"...when a student of chemistry makes his first acquaintance with the theory of atomic structure (quantum theory) he must come to understand the rather deep and subtle notion which has turned out to be the clue to unraveling that whole domain of physical experience. This is the notion of complementarity, you may know this under the rubric of wave particle duality, which recognizes that recognizes that various ways of talking about physical experience may each have essential validity and may each be necessary for the successful description of the physical world and yet may appear to exclude one another, so that to a situation where one viewpoint applies there may be no consistent possibility of applying the other." ...J. Robert Oppenheimer

### **Progress is a by-product of Science**

"But no scientist, no matter how aware he may be of these fruits of his science, cultivates his work, or refrains from it, because of arguments such as these. No scientist can hope to evaluate what his studies, his researches, his experiments may in the end produce for his fellow men, except in one respect – if they are sound, they will produce new knowledge."

J. Robert Oppenheimer lecturing at MIT on November 25, 1947

"Physics [science] is Like Sex, Surely it leads to many useful outcomes, but that is not why we do it!"

Richard Feynmann Nobel Laureate in Physics 1965.

# Science is membership in an open and global community.

Welcome to that community

## Have a great two weeks

we are so glad to have you here.