Michigan Chapter
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Michigan Chapter
AVS: The Science and Technology Society
Dinner Meeting
Thursday, March 7, 2002

Featuring the 2001 AVS Medard W. Welch Award Winner

An atomic view of the dynamic role of defects in determining physical and chemical properties of surfaces

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The variable temperature scanning tunneling microscope is presenting an unprecedented view of the importance of defects in all aspects of surface phenomena. What is must surprising is that in many cases it is the dynamic behavior of the defects that is crucial. In this talk I will discuss several recently discovered examples illustrating that we need to take a fresh look at the dynamic role of defects at a surface or interface. The first example is associated with a complex symmetry lowering ($\sqrt{3}x\sqrt{3}$) to (3x3) phase transition in the ultra-thin film of Sn on Ge(111). The study of macroscopic properties of phase transitions in low-dimensional systems provides an understanding of the fundamental aspects of systems of interacting particles. Phase transitions are strongly affected by defects, especially in systems with lower dimensionality. In quasi-1D or –2D systems that exhibit a charge density wave (CDW) transition, a small proportion of microscopic disorder can control the global properties because of the collective nature of the phenomena. It has been speculated that the interaction of mobile defects with CDW leads to alignment of defects with the CDW, or the formation of Defect Density Waves[1]. In this dynamic picture, the distribution of defects is neither random nor static, instead defects align their positions to optimize the energy of the pinned CDW. Here, in this system and similar systems the transition can be decomposed into two intertwined phase transitions: a second order CDW transition and a first order disorder-order transition in the defect distribution[2,3] The second example is the observation of an incommensurate Defect Density Wave in the Sn/Si(111) system[4]. Finally I will end with the beautiful work of the Salmeron's group on the role of subsurface impurities in Pd(111)[5]. These mobile impurities interact with adsorbed atoms and molecules, limiting surface diffusion, nucleating island growth, and serving as active sites for surface reactions.

[1]H. Mutka, in *Advances in the crystallographic and microstructural analysis of charge density wave modulated crystals,* edited by F. W. Boswell and J. C. Bennet, Kluwer Academic Publishers, Dordrecht, 1999.

[2]A complex structural phase transition in a defect populated 2D system, A. V. Melechko, M. Simkin, N. F. Samatova, J. Braun, and E. W. Plummer, Phys. Rev. B, **64**, 235424 (2001).

[3]Two-Dimensional Phase Transition Mediated by Extrinsic Defects, A. V. Melechko, J. Braun, H. H. Weitering, and E. W. Plummer, Phys. Rev. Letters, **83**, 999 (1999). Defect-Mediated Condensation of a Charge Density Wave, (H. H. Weitering, A. Melechko, J. M. Carpinelli, and E. W. Plummer), H. H. Weitering, A. Melesko, J. M. Carpinelli, and E. W. Plummer, Science**, 285**, 2107-2110 (1999).

[4]Direct visualization of Defect Density Waves in 2D, L. Ottaviano, A. V. Melechko, S. Santucci, and E. W. Plummer, Phys. Rev. Lett.**86**, 1809 (2001).

[5]Subsurface Impurities in Pd(111) Studied by Scanning Tunneling Microscopy, M. K. Rose, A. Borg, T. Mitsui, D. F. Ogletree, and M. Salmeron, Submitted

MEETING LOCATION, TIMES, AND DIRECTIONS ON REVERSE SIDE

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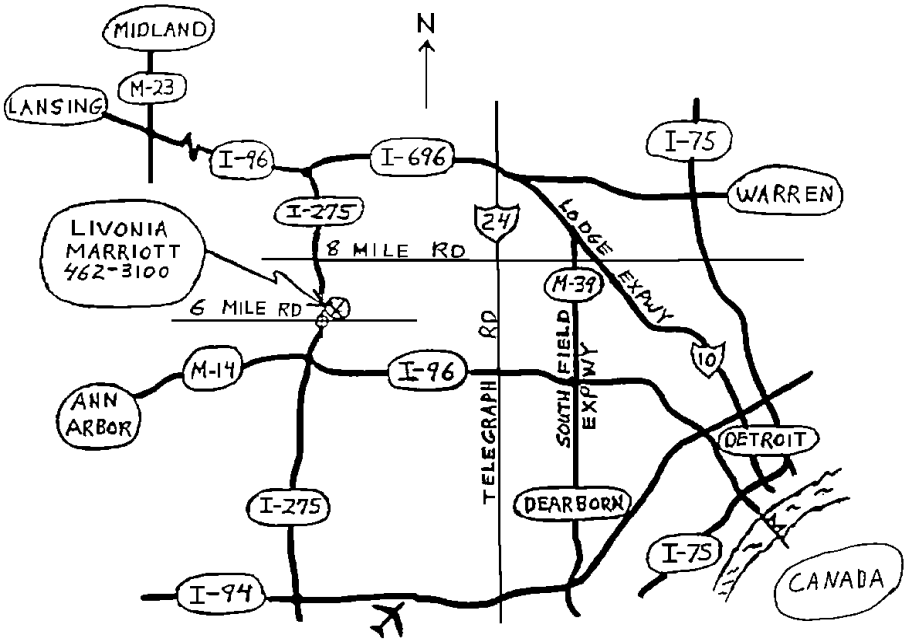
Location: **Livonia Marriott Hotel**, (734) 462-3100
on Six Mile Road just east of I-275
(see map below)

Fee: Members (and Non-Members) - $25.00, Full-time students with identification - $10.00. Payment by check or cash is appreciated. Credit cards are **not** accepted.

Schedule: 5:00-6:00 PM Board Meeting
6:00-6:30 PM Cash Bar
6:30-7:30 PM Dinner
7:30-8:45 PM Seminar

Reservations: Please send e-mail to: Steve Yalisove (smy@umich.edu) by **Friday, March 1, 5:00 pm** for reservations

Directions to the Livonia Marriott:



About Ward Plummer:

E. Ward Plummer is a Distinguished Professor of Physics at The University of Tennessee and a Distinguished Scientist in the Solid State Division of Oak Ridge National Laboratory. He received a Bachelor of Arts degree from Lewis and Clark College in 1962 and completed his Ph.D. degree in physics at Cornell University in 1967, working with Prof. Thor Rhodin. His thesis work on atomic binding of 5-d transition-metal atoms using FIM led to him receiving the Wayne Nottingham Prize at the Annual Physical Electronics Conference of the American Physical Society in March 1968.

Plummer accepted a National Research Council Postdoctoral Fellowship at the National Bureau of Standards [now called The National Institute of Standards and Technology (NIST)] in the fall of 1967 working with Russ Young, and he stayed as a staff scientist until the fall of 1973.

In 1973, Plummer accepted a position in the Physics Department at the University of Pennsylvania where his work mainly focused on angle-resolved photoemission, momentum-resolved inelastic electron scattering and nonlinear optical response from surfaces. In March1983, he was awarded the Davisson-Germer Prize by the American Physical Society for "---the innovative application of electron spectroscopies." In 1988, he was appointed the William Smith Professor of Physics and in 1990 became the director of the NSF-funded Materials Research Laboratory (Laboratory for Research on Structure of Matter).

In January 1993, Plummer moved to his present joint position at The University of Tennessee, Knoxville, and Oak Ridge National Laboratory. His research interests have shifted to the study on an atomic scale of phase transitions in reduced dimensionality and surfaces of highly correlated electron systems such as transition-metal oxides. His primary research tool has been variable-temperature scanning tunneling microscopy. This October, he will be awarded the Medard W. Welch Award by the American Vacuum Society (AVS) for his research over the last 10 years. The citation reads, "For the development of novel instrumentation, its use to illuminate new concepts in the surface physics of metals, and the mentoring of promising young scientists." The Welch Award was established in 1969 to commemorate the pioneering efforts of M. W. Welch in founding and supporting the AVS. Recipients receive a cash award, certificate, and gold medal. In 2000, Plummer became the Director of the Tennessee Advanced Materials Laboratory, a state-funded Center of Excellence.

He is author of ~300 refereed papers and is included in the list of the 1,000 Most Cited Physicists, a list compiled by the Institute for Scientific Information which is based on papers published between 1981 and 1997. But what Plummer is proudest of in his long and distinguished career is the mentoring of promising young scientists. To date, this includes advising or co-advising Ph.D. theses of 40 graduate students, hosting ~25 postdoctoral fellows, and assisting many young scientists in advancing their careers.

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