Nanoscale Science and Technology Division
Room Oregon Ballroom 203-204 - Session NS-TuP

Nanoscale Science and Technology Poster Session

NS-TuP-1 AVS Dorothy M. and Earl S. Hoffman Awardee Talk: Scalable and Sustainable Synthesis of ZnO Nanowires via Hot Water Treatment for Photocatalytic Applications, ***Ranjitha K. Hariharalakshmanan*** [1] , *F. Watanabe, T. Karabacak,* University of Arkansas at Little Rock

There is growing interest in developing cost-effective and sustainable methods to synthesize photocatalysts that can be immobilized on substrates. In this study, we present a novel and ultra-scalable method for synthesizing ZnO nanowires that are immobilized on the surface of Zn plates using a hot water treatment (HWT) technique. This straightforward synthesis method involves immersing Zn coupons in deionized water at 75 °C without any chemical additives or precursors. SEM, TEM, EDS, XRD, XPS, and UV-Vis spectroscopy analysis on the surface of Zn after 5 hours of HWT showed the formation of well-developed, hexagonally-faceted, stoichiometric, and crystalline ZnO nanowires with a bandgap of 3.26 eV. To evaluate the photocatalytic activity of these ZnO nanowires, we performed methylene blue degradation tests under UV light. 93% of methylene blue was degraded in 120 minutes with a reaction rate constant of 0.021 min^{-1}. Overall, our findings demonstrate the potential of HWT as a scalable and environmentally-friendly method for synthesizing ZnO nanostructures with excellent photocatalytic properties.

NS-TuP-2 Nanopore Arrays Patterned by Thermal Scanning Probe Lithography for Electrochemical Biosensing, ***Ken Bosnick***, *J. Canlas, E. Kamali,* National Research Council of Canada

The use of nanopore arrays for electrochemical sensing represents an exciting avenue for improved detection of biomolecules. Through chemically modifying the nanopore arrays, sensitive and selective platforms can be engineered that exploit a transport-modulation-based amplification, whereby one analyte molecule can block multiple electrochemical reporter molecules [1]. This poster will report on the fabrication of such nanopore arrays using thermal scanning probe lithography in ultrathin dielectric layers on electrochemically active conductors (e.g., ALD SiO_2 on ITO).

[1] Róbert E. Gyurcsányi, "Chemically-modified nanopores for sensing", Trends Analyt. Chem. 27 (2008) 627-639

NS-TuP-3 Tunable Gold- and Aluminum-Nanocrescents as a Platform for Circular Dichroism Spectroscopy, ***Anh Nguyen,*** University of Utah

Gold (Au) has been a common material for plasmonic nanostructures studies. Although aluminum (Al) has several advantages over gold and is a promising material for nanoscience studies, the complication of the ubiquitous alumina film in Al nanostructures' fabrication limits its use. With the copper mask nanosphere template lithography fabrication method, our group has successfully fabricated both Au- and Al-nanocrescents (NCs) despite the challenges that arise from the native oxide layer of Al. Both Au- and AlNCs exhibit multimodal, polarization-dependent plasmons that can be tuned in different spectral regions. However, AuNCs' plasmon resonances are red-shifted compared to AlNCs due to the difference in surface properties. Moreover, chiral plasmonics is recently an area of particular interest in the rich and diverse field of plasmonic nanostructure studies. The fundamental focus of chiral plasmonics is to probe the difference in the nanostructures' ability to absorb left vs. right circularly polarized light. Au- and AlNCs have shown the properties of extrinsic chiral nanostructures, which have CD response when titled to out-of-plan incident angles with respect to the incident circularly polarized light. At θ=±30° out-of-plane incident, the Au- and AlNCs' true CD responses are equal in ellipticity but opposite in handedness. In addition, the Au- and Al-NCs exhibit the opposite chiral response when rotated 180°relatives to the sample's orientation at θ=±30° . There is no handedness response for true CD of both Au- and AlNCs at normal incidence, which confirms the extrinsic chiral optical properties of the system. Conversely, there is negligible handedness response for the birefringence of Au- and Al-NCs at both normal and out-of-plane incident angles. These optical phenomena define that the nanocrescents system is an isotropic orientation averaging where there is little to no change in the original substrate surface forward/backward CD response as well as exhibits true CD behavior. These results have produced novel insight into understanding the chiral optical and resonant plasmonic support in nanostructures and opens further investigation into the use of Au- and Al-nanostructures in sensing and detection.

NS-TuP-4 Towards Artifact-Free Atomic Force Microscopy Images, ***Nancy Burnham***, Worcester Polytechnic Institute*; L. Lyu,* Chang'an University, China*; L. Poulikakos,* Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland

Atomic force microscopy (AFM) is based upon a simple operational principle. However, the presentation and interpretation of AFM images can easily suffer from consequential artifacts that are easily overlooked. Here we discuss results from AFM and its companion variations PF-QNM (peak-force quantitative nano-mechanical mapping) and AFM-IR (AFM combined with infrared spectroscopy) by imaging "bee" structures in asphalt binder (bitumen) as examples. We show how common problems manifest themselves, with the intent that authors can present their results clearly and avoid interpreting artifacts as true physical properties, thereby raising the quality of AFM research.

NS-TuP-5 Probing Metal Substrate Effects on the Adsorbate Conformations of a Nonplanar Tetrabenzoporphyrin Molecule by Ultra-high Vacuum Tip-Enhanced Raman Spectroscopy, ***Soumyajit Rajak***, *N. Jiang, D. Liu, L. Li,* University of Illinois - Chicago

Tetrabenzoporphyrin molecules are one of the most widely studied model biomolecules in organic optoelectronics for modern-age electronic device applications and catalysis. Opto-electronic properties in the nanoscale are controlled by the local nanostructures of a molecular arrangement. The local nanostructures are determined by the real-space molecular conformations. It is really challenging to determine the real-space surface adsorbed conformations of a molecule using ensemble-averaged surface science techniques. The molecular structure and the 2-dimensional crystalline arrangements of the tetrabenzoporphyrins are primarily defined by the symmetry of the porphyrin molecule and the steric and electronic nature of the groups linked at meso-positions and β-positions of the ring. The flexibility of the σ-bonded peripheral groups in the meso-positions can induce dynamic behavior in the porphyrin molecule and may give rise to different binding configurations on different metal substrates or sometimes even on one substrate. Herein we present a combined topographical and chemical analysis of different surface-adsorbed conformations and surface-sensitive arrangements of a symmetric tetrabenzoporphyrin molecule using angstrom-scale resolution scanning tunneling microscopy (STM) and ultra-high vacuum tip-enhanced Raman spectroscopy (UHV-TERS). Low temperature (77K) scanning tunneling microscopic images and localized surface plasmon resonance enhanced Raman signals reveal different adsorbate conformations of single molecule entities and a fundamental view of adsorbate-substrate binding interactions.

NS-TuP-6 Studies of Chemistry and Materials Approaching the Atomic Scale with Cryogenic Ultrahigh Vacuum Scanning Near-Field Optical Microscopy Methods, ***Jeremy F Schultz***, National Institute of Standards and Technology (NIST)*; L. Li, S. Mahapatra, N. Jiang,* University of Illinois Chicago*; A. Centrone,* National Institute of Standards and Technology (NIST)

Optical spectroscopies can be used to probe and characterize the composition as well as the physical and electronic structure of molecules and materials. By confining light-matter interactions into the near-field of a scanning probe microscope (SPM) the diffraction limit of light can be circumvented and the resulting measurements can consider composition and subtle local phenomena down to the nanoscale. In ultrahigh vacuum (UHV) and at cryogenic temperatures the spatial resolution of these methods can be pushed towards the atomic scale.

Scanning tunneling microscopy (STM) and tip-enhanced Raman spectroscopy (TERS) were used to investigate the behavior and chemistry of molecular adsorbates with surfaces. Spectroscopic imaging provides the ability to visualize highly localized phenomena, while vibrational fingerprints can be used to understand their effects on a molecule's or material's structure. This yields insight into adsorbate-substrate interactions crucial to the growth of nanostructures through surface chemistry, as well as the functionalization or modification of 2D materials.

Moving beyond UHV-STM-TERS, ongoing work focuses on the development of a new versatile cryogenic UHV-SPM platform for other measurements of light-matter interactions, specifically STM-induced luminescence (STML) and coupling pulsed infrared light into the tip-sample junction. STML leverages the atomically sharp STM tip as a probe to locally excite light emission and captures spectra that can be used to characterize excitonic

[1] **AVS Dorothy M. and Earl S. Hoffman Awardee**

behavior and vibronic structure. On the other hand, many relevant quantum phenomena occur in the infrared regime, which remains relatively unexplored with atomic scale near-field microscopy. Together, these capabilities are expected to result in a platform capable of studying properties of materials that would otherwise be inaccessible.

NS-TuP-7 Novel Air Spacer Technology for Parasitic Bit-Line Capacitance Reduction, ***Dongmin Han***, Department of Semiconductor and Display Engineering The Graduate School Sungkyunkwan University, Republic of Korea; *B. Choi,* Department of Electrical and Computer Engineering, Sungkyunkwan University, Republic of Korea

In this study, a novel air spacer using plasma nitridation (PN) technique for dynamic random acess memory (DRAM) device is investigated to minimize parasitic bit-line capacitance (Cb). The ratio of Cb to cell capacitance (Cs) is increasing due to smaller cell size. Thus, DRAM development faced great difficulties due to the decrease in bit-line sensing margin [1]. The Cb/Cs is a key factor in determining the bit-line sensing margin. In addition, Cs is expected to continue to decrease due to the physical limitations of cell capacitor technology, so technology that can lower Cb has become a key technology [2]. 20nm DRAM developed bit-line air spacer technology and greatly improved Cb [1]. However, Cb still needs additional improvements due to the continued reduction in bit-line spacer dimension. We improved the Si3N4 transition layer by using the plasma nitridation techniques before the deposition of the outer Si3N4 film. The pre-plasma nitriding treatment process forms an inter-diffusion and additional protective layer and improves the surface properties of the deposited film [3]. We used this technology to the air spacer. As shown in figure 1, it was expected to maximize the air layer thickness formed in the subsequent process by reducing the thickness of the transition layer formed during outer Si3N4 deposition. The Cb was measured using the test element group, which can measure air spacer pattern and non-air spacer pattern. the Cb improved by 2%, as shown in figure 2. It is considered that the portion of air thickness is increased through surface transition layer improvement. This is a simple and innovative approach to improve the characteristics of DRAM. This study proposed a new direction to improve the Cb/Cs Characteristic for a sub 20 nm DRAM device.

Reference

[1] Park, J. M., et al. IEEE International Electron Devices Meeting (IEDM) (2015)

[2] Hwang, Yoosang, et al. Solid State Devices and Materials (2012)

[3] Bashir, M. I., et al. Surface and Coatings Technology Vol.327, pg 59-65 (2017)

NS-TuP-8 Understanding Interaction Forces at Silicon Wafer Interfaces to Optimize Nanoscale Cleaning Processes, *D. Miano,* CEST GmbH, Austria; *L. Palla, A. Seltenhammer,* TU Wien, Austria; ***Pierluigi Bilotto***, CEST GmbH, Austria; *B. Loidl, S. Garvey,* Lam Research Corp., Austria; *M. Valtiner,* TU Wien, Austria

Miniaturization of electronics at the wafer surface is a possible answer to the growing demand of fast, cheap, and environmentally friendly devices. This strategy arises a question on how nanometer size particles, which could impact the yield of nanoscale electronics, could be removed from the wafer surface. The current state-of-the-art in wafer cleaning processes is based on subsequents streams of solvents (e.g., mega-sonic cavitation[1]) on rotating disks,[2] but such protocols can alter the surface to a level which is significant for nanoscale electronics, and do not affect nanoscale level particles. More than ten years ago, it was discussed that surface nanobubbles can remove nano particles,[3] but the understanding is still limitated to a qualitative description of the phenomenon.
In this project, we aim to shed light on the interaction between surface nanobubbles and nanoparticles, in order to finally clarify the physical-chemical interaction at the interface which can lead to a nanoscale-cleaning-process.
In this poster, I will show our innovative design of a microfluidic system applied to an atomic force microscope.
We utilize thiol functionalization to define model systems and mimic the different interaction forces, explaining according to the DLVO theory, and that might take place onto a wafer surface during its industrial cleaning process.
In parallel we also cover with different size nanoparticles our surfaces, that should reproduce the possible impurity of a real Si surface, we study if it is possible to use the solvent exchange for remove these objects and we try to understand how to implement the cleaning process protocol. I will display our results and comments on what are the possible key elements participating in the nanoscale-cleaning-process.
The finding of this work are not only relevant from a fundamental point of view, but have a clear industrial application which is why we collaborate with top industrial partners in the field of semiconductor and wafer cleaning.

References:[1] Ahmed A. Busnaina et al 1995 J. Electrochem. Soc. 142 2812[2] D. Prieling, H. Steiner, International Journal of Heat and Mass Transfer 65, 10-22, 2013[3] Shangjiong Yang and Anton Duisterwinkel; Langmuir 2011, 27, 11430–1

NS-TuP-9 The Design of Thermal Cloak Using Nanoporous Thin Films, ***Yue Xiao***, Advanced Cooling Technologies, Inc.; *Q. Chen, Q. Hao,* University of Arizona

In recent years, nanoporous thin films are widely studied as an effective way to manipulate the thermal transport within thin-film-based devices. In practice, nanoporous patterns can effectively cut off the heat flow and thus guide the thermal transport along the desired direction. However, a better design of these thermal devices is not addressed, such as thermal cloaking as the thermal counterpart for optical invisibility cloaks. In existing designs based on the Fourier's law, composite materials with varied structures are often introduced to achieve the required location-dependent thermal conductivities to distort the heat flux. At the micro-to nano-scale, such designs are difficult to be implemented and factors such as the interfacial thermal resistance must be further considered. In this work, inverse thermal designs of a nanoporous material are used to achieve the thermal cloaking effect for 2D materials or 3D thin films, without introducing any other variation of the composition or material to tune the local thermal conductivity. This simple approach can be widely used for thin-film-based devices to protect heat-sensitive regions or function as thermal camouflaging devices. The proposed nanoporous structures can also be used to tune the local properties of a thin film for general applications, such as graded thermoelectric materials.

NS-TuP-11 Control and Manipulation of Superconducting Vortex Lattices from Nano to Mesoscales, *S. Song, J. Yan,* Oak Ridge National Laboratory; *W. Ko,* University of Tennessee Knoxville; *E. Dumitrescu, G. Halasz,* Oak Ridge National Laboratory; *H. Fangohr,* Max Planck Institute for Structure and Dynamics of Matter, Germany; *C. Ha, B. Lawrie,* ***Petro Maksymovych***, Oak Ridge National Laboratory

When a magnetic field larger than a lower critical field is applied to a type-II superconductor, magnetic fluxes will pass through the volume of the superconducting material, creating a vortex state. Vortices exhibit a rich structural diagram, with the possibility of vortex liquid, glass, and lattice states determined by the material properties and external parameters. On a fundamental level, single and few vortex manipulation opens a pathway to understand vortex properties and to tailor their dynamics to prospective applications in quantum computing.

We will discuss two experiments using scanning tunneling microscopy (STM) which demonstrate direct control over vortex positions in FeSe superconductor. First, we observed that the twin boundary in the FeSe superconductor traps a relatively high density of vortices and acts as a barrier that aligns the vortices on the terrace parallel to the twin boundary. The alignment effect causes various phases of vortex lattice structures such as rectangular and one-dimensional vortex lattices – both with ordering qualitatively different from the commonly observed vortex glass. The analysis of these interactions also reveals further clues regarding vortex dynamics, inter vortex interaction, and vortex pinning, and directly points to strain fields as possible effective approach for accurate control over vortex structures. Second, we found that the vortex shape can be controllably varied with the imaging conditions in STM, particularly at the extreme limit of very large local current density. We attribute the observations as direct evidence of vortex manipulation, by contrasting the behaviors of various types of vortices in proximity to twin boundaries on FeSe. Altogether we suggest that precise control over the high tunneling current, combined with specific structural topological defects, can translate into an effective strategy for vortex manipulation approach without destruction of the superconducting state, enabling STM to become a quantitative nanoscale probe of vortex dynamics and a platform to explore vortex manipulation in the context of topological quantum computing.

Work supported by the U.S. Department of Energy, Office of Science, Materials Sciences and Engineering Division. Experiments were carried out as part of the user project at the Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, which is a US Department of Energy Office of Science User Facility.

S. Y. Song, C. Hua, L. Bell, W. Ko, H. Fangohr, J. Yan, G. B. Halász, E. F. Dumitrescu, B. J. Lawrie, P. Maksymovych, *Nano Lett.*23(2023)2822.

NS-TuP-12 Exploring the Complex Chemistry and Degradation of AscorbicAcid in Aqueous Nanoparticle Synthesis*, **Debashree Roy**, L. Moreau,* Washington State University

While ascorbic acid (AA) has been the ubiquitous choice as a mild reductant in the aqueous synthesis of noble metal nanoparticles (NPs), its role beyond the reducing powers has been mostly overlooked. Despite the fact that reduction kinetics of metal salt precursors are most susceptible to modifications by reducing agents, it has frequently been relegated to concentration and pH variations for AA, without delving into the more complex chemistry associated with the latter. The mechanism behind AA-mediated reduction is often stymied by an oversimplified presentation in literature wherein the diprotic acid is assumed to undergo consecutive oxidations via a radical intermediate to form dehydroascorbic acid (DHA). In reality, these assumptions may not accurately describe the aqueous behaviour of AA in a wide array of synthetically relevant conditions.

We show that facile degradation of ascorbic acid has considerable impacts on the formation and properties of aqueous silver NPs and discuss implications for the use of ascorbic acid in NP synthesis. Briefly, experimental evidence shows that the alkaline degradation of AA at no point converges to yield DHA, which follows an independent degradation pathway altogether. While DHA at different stages of degradation consistently results in the formation of spherical/quasi-spherical Ag NPs, it is interesting to note that AA aged for > 12h gives rise to anisotropic plate-like morphology, furthering the hypothesis that a different degradation pathway is followed for both. The role of various plausible degradation products has been additionally studied to inform AA's assumed behaviour in NP synthesis. These findings have profound implications for the understanding of AA in NP systems, and the mechanisms behind its role as a reductant and surfactant.

NS-TuP-13 Exploiting Mixed-Dimensionality in Hybrid Van Der Waals Heterostructures*, **Emanuele Orgiu**,* Institut National de la Recherche Scientifique / University of Quebec, Canada

2D Quantum Materials are held together by weak interplanar van der Waals (vdW) interactions. The incorporation of molecules in such materials holds an immense potential to understand and modify the fundamental physical properties of the pristine materials while creating new artificial materials. Whilst nature offers a finite number of 2D materials, an almost unlimited variety of molecules can be designed and synthesized with predictable functionalities. The possibilities offered by systems in which continuous molecular layers are interfaced with inorganic 2D materials to form hybrid organic/inorganic van der Waals heterostructures (H-vdWH) are emphasized. Similar to their inorganic counterpart, the hybrid structures have been exploited to suggest novel device architectures. Moreover, specific molecular groups can be employed to modify intrinsic properties and confer new capabilities to 2D materials. In particular, I will highlight how molecular self-assembly at the surface of 2D materials can be mastered to achieve precise control over position and density of (molecular) functional groups, paving the way for a new class of hybrid functional materials.

In particular, I will show how the presence of ordered supramolecular assemblies bearing different functional groups can modify the pristine Shubnikov-De Haas oscillations [1] occurring in graphene or tune the magnetoresistance in a given transition metal dichalcogenide [2].

[1] A. Pezeshki, A. Hamdi, Z. Yang *et al*., ACS Appl. Mat. Interf. 13, 26152 (2021).

[2] A. Hamdi, A. Pezeshki, .. E. Orgiu, Manuscript i*n preparation*.

NS-TuP-14 Circuit-Level Device Modeling for Framework Analyzing Hot Carrier Injection Failure in Gate-All-Around (GAA) Charge Trapping Flash (CTF) Memory Devices Based on New Experimental Methodology*, **Sunghwan Cho**,* Samsung Electronics Co., Inc., Republic of Korea

To overcome the limitation of conventional planar flash memory in scaling down, gate-all-around (GAA) charge trapping flash (CTF) memory gradually become the most promising alternative due to remarkably larger storage and less disturbance. However, as stacking more layers vertically and getting smaller in feature size, it is inevitable that device failures attributed to interference or leakage such as band-to-band tunneling (BTBT) and hot carrier injection (HCI) increase rapidly. Furthermore, a suitable framework to analyze failure mechanisms and optimize design by using circuit simulation is insufficient. In this paper, we proposed circuit-level device modeling as a framework focused on HCI failure analysis in GAA CTF, which is achieved by establishing new method in measuring HCI effect and optimizing model parameters by derived formula. As shown in Fig. 1, threshold voltages in non-programmed memory cell can be increased unexpectedly by HCI effect, which results in critical failure and degradation of performance. In conventional junction-less GAA CTF memory devices, electrons generated by BTBT in a large gap in boosted channel potential and high electric field in vertical direction contribute to HCI effect. As a result, circuit-level modeling for accurate calculation of boosted channel potential and determination of gate voltages in a cell string is essential in analyzing HCI effect. Fig. 2(a) and (b) illustrate single modeling structure and equivalent circuit attaching voltage-controlled-current sources which execute essential current flow in GAA CTF such as Fowler-Nordheim (FN) tunneling, BTBT and HCI leakage by using derived formula in our work. By connecting single modeling units serially as shown in Fig. 2(c), circuit-level modeling structure with a cell string unit is proposed which makes prediction of boosted channel potential and BTBT/HCI current more accurate. Fig. 3 presents mechanisms of HCI in the proposed experimental method. Since the amount of HCI leakage is determined by 2 dominant conditions which are potential difference in lateral direction generating BTBT and electric field in vertical direction, we separated 2 measurement conditions, as shown in Fig. 3(a) and (b), to extract model parameters compactly by breaking down 2 terms. Furthermore, since HCI failure commonly occurs at the end of channel, we enhanced experimental progress by measuring near gate select line (GSL) transistor, as shown in Fig. 3(c). Finally, the fitting results show good agreement with experimental data, as shown in Fig. 4, which means the proposed model would equip circuit designer of GAA CTF by analyzing failure mechanism and optimizing the performance.

NS-TuP-15 Statistic Analysis of Nanoscale Tunneling Electrical Contacts Based on Transmission Line Model*, **Bingqing Wang**, P. Zhang,* Michigan State University

The rising interest in innovative electronic circuits utilizing low-dimensional materials, like carbon nanotubes (CNTs), has made nanoscale contact engineering increasingly important. This study investigates the influence of contact resistances between carbon nanotubes (CNTs) on electron transport and electrical conductivity of carbon nanofibers (CNFs), which profoundly impacts the performance of CNT thin film field effect transistors (FETs)[1]. Utilizing a self-consistent contact model, we integrate a transmission line model with tunneling current model [2] to calculate the plethora of parallel CNT-CNT contacts within individual fibers. A statistical analysis is conducted, using Gaussian distributions to account for variations in contact lengths, gap distances, and single CNT aspect ratios, and producing data on CNT-CNT contact resistance and the overall resistance of CNT fiber. By scaling our model to a macroscopic level, our results are in significant alignment with experimental measurements [3]. Our calculation suggests that while increasing overlap length diminishes individual CNT-CNT contact resistance, it paradoxically increases macroscopic CNT fiber resistance, given a constant CNF mass density. Similarly, greater gap distance also increases both individual and fiber resistance. This research provides a tool for exploring CNT fiber electrical properties, promoting advancement in low-dimensional material-based electronic circuit development. Future work could leverage machine learning for establishing the correlations between different parameters and identify the optimal parameter values that most accurately represent the experimental results.

1. S. B. Fairchild, et al., Morphology dependent field emission of acid-spun carbon nanotube fibers, Nanotechnology 26, 105706 (2015).
2. Banerjee, S., Luginsland, J. & Zhang, P. A Two Dimensional Tunneling Resistance Transmission Line Model for Nanoscale Parallel Electrical Contacts. Sci Rep 9, 14484 (2019)

3. D. Tsentalovich, et al, Influence of Carbon Nanotube Characteristics on Macroscopic Fiber Properties, ACS Appl. Mater. Interfaces, 9, 36189 (2017)

* Work is supported by the Air Force Office of Scientific Research (AFOSR) Award No. FA9550-22-1-0523.

NS-TuP-16 Instrumentation of Ptychographic Microscopy at the Atomic Scale, ***Chien-Nan Hsiao***, *F. Chen,* Taiwan Instrument Research Institute, National Applied Research Laboratories, Taiwan*; T. Chung,* Department of Materials Science and Engineering, National Yang Ming Chiao Tung University, Taiwan*; C. Chen,* Department of Engineering and System Science, National Tsing Hua University, Taiwan

Ptychographic electron microscopy at atomic-scale resolution had been established. A hybrid pixelated detector and remote controlled electron beam scanning coil were integrated on an aberration corrected scanning transmittance electron microscopy with a circular C2 aperture of 10 µm. Experimental results shown that the 128×128 steps of electron probe interval (1 Å) in real space with the size of each diffraction pattern is 512×512 pixels in high dynamical range. The 4D cube data of sampling areas were stable acquired at 200 kV with high diffraction space resolution. In addition, phase retrieval algorithms were developed to improve the point resolution of coherent diffraction imaging. Moreover, the lattice strain mapping was simultaneously interpreted with the high angle annual dark field image in nanostructural characterization by analysis the convergent beam electron diffraction patterns.

NS-TuP-17 Influence of Defects on Oxidation of Rhodium, ***Allison Kerr***, *M. Gillum, D. Killelea,* Loyola University Chicago

Due to the importance of oxide surfaces in heterogeneously catalyzed oxidation reactions, it is necessary to gain a fundamental understanding and behavior of oxygen on transition metal surfaces. Additionally, the atomic arrangement of the metal surface plays an important role in the behavior of the oxygen on the surface, which provides a need to study high defect density surfaces that are more akin to industrial catalysts. The research presented herein utilizes a curved rhodium crystal c-Rh(111) with two different well-defined defects on either side to conduct a systematic study of the influence of defect geometry on the kinetics and dynamics of different oxygen species present on the surface. Scanning tunneling microscopy (STM), low energy electron diffraction (LEED), temperature programmed desorption (TPD), and Meitner-Auger electron spectroscopy (MAES) will be used to look at the surface on an atomic scale and to observe what chemical species are on the surface after introducing oxygen into the vacuum environment.

Author Index

Bold page numbers indicate presenter