UNIVERSITY of HOUSTON

TEXAS CENTER FOR SUPERCONDUCTIVITY

58th TcSUH Student Research Symposium

Friday, April 28, 2023

Welcome, Student Presentations, and Announcement of Symposium and Scholarship Winners
10:25 a.m. – 4:30 p.m.
University of Houston Science Center, Room 102

BBQ Lunch Buffet
11:45 a.m. – 12:45 p.m. – RSVP
https://forms.office.com/r/jBpmeF7dbE

Agenda

Judges: Prof. **Jiming Bao**, ECE; Prof. **Audrius Brazdeikis**, PHY; Prof. **Arnold Guloy**, CHEM
Prizes: 1 First Prize ($600); 2 Second Prizes ($300); 3 Third Prizes ($200).
[Winners are eligible for TcSUH Travel Grants of First Prize – $1000, Second Prize – $300, and Third Prize – $200.]

10:00 a.m. Coffee, Tea – 1st Floor Lobby

10:25 a.m. **Welcome; Introduction of Judges and Chairs; Guidelines for Review –** Zhifeng Ren, Director, TcSUH

10:30 a.m. **SESSION I** Chair: Prof. James K. Meen, Chemistry

10:30 –10:45 Ms. Tania Ghosh, Ph.D. student, Physics
(Prof. Kevin Bassler, adviser)
Extreme Value Statistics of Community Detection in Complex Networks with Reduced Network Extremal Ensemble Learning (RenEEL)

10:45 –11:00 Mr. Xin Shi, Ph.D. student, Physics
(Prof. Zhifeng Ren, adviser)
Physical Origins of the Distinct Transport Behavior Among Thermoelectric AMg_2Sb_2 Compounds (A = Ca, Sr, Sm, Yb, and Mg)

11:00 –11:15 Mr. David Waligo, Ph.D. student, Physics
(Prof. Oomman Varghese, adviser)
Role of Scattering in the Prediction of Simulation-Based Optical Properties of Dielectric TiO_2 Nanotubular Materials

11:15 –11:30 Mr. Bhabesh Sarangi, Ph.D. student, Materials Science & Engineering
(Prof. Venkat Selvamanickam, adviser)
Double-Sided RE-$Ba_2Cu_3O_{7-\delta}$ Tapes by Advanced MOCVD with Critical Current Over 500 A/4mm at 20 K, 20 T

11:30 –11:45 Mr. Chaoshan Wu, Ph.D. student, Materials Science & Engineering
(Prof. Yan Yao, adviser)
Mixed-ionic-electronic-conducting Interlayer Design for High-Performance Solid-State Lithium-Metal Batteries

11:45 – 12:45 **TcSUH BBQ Buffet Lunch**

1:00 p.m. **Announcement of 2023 – 2024 TcSUH Scholarship Recipients**

1:10 p.m. **Afternoon Sessions – Call to Order**
Zhifeng Ren, Director, TcSUH

SESSION II Chair: **Dr. Lihong Zhao, Electrical & Computer Engineering**

1:10 –1:25 Mr. Abhijit Bera, Ph.D. student, Physics
(Prof. Kevin Bassler, adviser)
Decomposition of Anomalous Diffusion in Levy Walks with Finite Step Duration

1:25 –1:40 Mr. Jacob Hickey, Ph.D. student, Chemistry
(Prof. Jakoah Brgoch, adviser)
The Limits of Proxy-Guided Superhard Materials Screening

1:40 –1:55 Mr. Daniel J. Schulze, M.S. student, Physics
(Prof. Paul C. W. Chu, adviser)
Magnetism and Superconductivity in Kagome $CeRu_2$ at Megabar Pressures

1:55 –2:10 Mr. Surya Pratap Singh Solanki, Ph.D. student, Chemical & Biomolecular Engineering (Prof. Lars Grabow, adviser)
Dynamically Excited Catalysts with Superior Oxidation Activity

2:10 –2:20 Break / Drawing for Door Prizes (must be present to win)

2:20 p.m. **SESSION III** Chair: **Prof. Prof. Vassiliy Lubchenko, Chemistry**

2:20 –2:35 Mr. Minh Dang Nguyen, Ph.D. student, Chemistry
(Prof. T. Randall Lee, adviser)
Tailoring the Size, Shape, and Crystallinity of Iron Oxide Nanoparticles for Studies of Nano-Magnetism and their Potential Applications

2:35 –2:50 Mr. Minghui Ning, Ph.D. student, Physics
(Prof. Zhifeng Ren, adviser)
Direct Alkaline Seawater Electrolysis: Challenges and Solutions

2:50 –3:05 Ms. Mina Moradnia, Ph.D. student, Mechanical Engineering
(Prof. Jae-Hyun Ryou, adviser)
Single-Crystalline III-N Film Growth for Photonic, Electronic, Sensing, and Energy Harvesting Applications

3:05 –3:20 Ms. Lilly Schaffer, Ph.D. student, Physics
(Prof. Oomman Varghese, adviser)
Improving the Phase Purity of Nanocrystalline Cu_2SnS_3 Films Fabricated using Solution-Based Precursors for Solar Cell Applications

3:20 –3:35 Ms. Fengjiao Pan, Ph.D. student, Physics
(Prof. Zhifeng Ren, adviser)
Observation of Persistent Hot Carrier Diffusion in Boron Arsenide Single Crystals Synthesized by Chemical Vapor Transport Method

3:35 p.m. **Closing of Sessions** – Prof. Zhifeng Ren
Deliberation of Judges

3:45 p.m. **Photo of all Presenters** – *Outside, if weather permitting; or HSC 1st Floor Lobby, red wall*

3:55 p.m. **Announcement of Symposium Winners** – Zhifeng Ren

4:00 p.m. **Photo of Symposium Prize Winners**
Photos of 2023 – 2024 Scholarship Winners

RSVP for Lunch Buffet by April 24, 2023.
https://forms.office.com/r/jBpmeF7dbE

Awards: First Prize (one prize): $600; Second Prize (two prizes), $300; Third Prize (three prizes): $200. Judges are selected from TCSUH Faculty members. Prizes will be awarded based on originality of research (25%), quality of research (25%), quality of presentation (25%), and skillful use of visual aids (25%). For fairness, the judges' decisions will be normalized so that undergraduates and graduates can compete on an equal footing. Cash prizes will not be presented at the Symposium. The winners will receive their cash prize as a supplement to their paycheck. Winners will be interviewed for a press release.

Door Prizes: Great door prizes from local merchants will be given throughout the Symposium! Each attendee will receive a special ticket at the door and must be present at the drawings to win.

ABSTRACTS

Each presentation is allotted 15 minutes, including 4-5 minutes for Q&A.

SESSION I

Chair: **Prof. James K. Meen, Chemistry**

10:30-10:45 **Ms. Tania Ghosh**, Ph.D. student, Physics (Prof. Kevin Bassler, adviser)

Extreme Value Statistics of Community Detection in Complex Networks with Reduced Network Extremal Ensemble Learning (RenEEL)

Arguably the most fundamental problem in Network Science is finding structure within a complex network. One approach is to partition the nodes into communities that are more densely connected than one expects in a random network. "The" community structure corresponds to the partition that maximizes a measure that quantifies this idea. Finding the maximizing partition, however, is a computationally difficult NP-Complete problem. We explore the use of a recently introduced algorithmic scheme [Guo, Singh, and Bassler, *Sci. Rep*. **9**, 14234 (2019)] to find the structure of a set of benchmark networks. The scheme, known as RenEEL, creates an ensemble of k partitions and updates the ensemble by replacing its worst member with the best of k' partitions found by analyzing a simplified network. The updating continues until consensus is achieved within the ensemble. Varying the values of k and k', we find that the results obey different classes of extreme value statistics, and that increasing k is generally much more effective than increasing k' for finding the best partition.

Tania Ghosh [1,2], R.K.P. Zia [1,3], and Kevin E Bassler [1,2]
[1]Department of Physics, University of Houston, Houston, Texas
[2]Texas Center for Superconductivity, University of Houston, Houston, Texas
[3]Department of Physics, Virginia Tech, Blacksburg, VA

Bio: Tania Ghosh is a 3rd year grad student in the Department of Physics at the University of Houston. She is working with Dr. Kevin E. Bassler. Her research concerns methods of finding modular structure in complex network systems and relating the nonlinear dynamics of the systems to that structure. Her work has important applications to a wide variety of physical, biological, and social systems.

10:45 –11:00 **Mr. Xin Shi**, Ph.D. student, Physics (Prof. Zhifeng Ren, adviser)

Physical Origins of the Distinct Transport Behavior Among Thermoelectric AMg$_2$Sb$_2$ Compounds (A = Ca, Sr, Sm, Yb, and Mg)

Contrary to the similar p-type thermoelectric performance in both AZn$_2$Sb$_2$ and AMg$_2$Bi$_2$ compounds, AMg$_2$Sb$_2$ can exhibit thermoelectric figure of merit (zT) values that vary by orders of magnitude with different A elements. Herein, underlying mechanisms accounting for the distinct thermoelectric performance among AMg$_2$Sb$_2$ (A = Ca, Sr, Sm, Yb, and Mg) compounds, not systematically explored before, are unveiled through comprehensive analyses of their electrical and thermal properties from both experimental and theoretical standpoints. It is found that the main reason for the macroscale disparity in their thermoelectric performance lies in the widely varying acceptor levels (E_A) that an equal amount of p-type dopant can induce in their electronic band structures. In addition, several other previously unreported behaviors for AMg$_2$Sb$_2$ have also been identified, such as the anomalous carrier concentration in the Sm-based compound due to its unusual Sm valence state, and the violation of the empirical mass–lattice thermal conductivity connection in these materials, rationales for which will also be presented. This mechanism-focused study can promote a deeper understanding of the complex carrier and phonon transport behavior in condensed matter and can serve as a guide toward rationally tuning physical properties of materials.

Bio: Mr. Xin Shi is currently a 4th year graduate student and Ph.D. candidate from the Department of Physics and Texas Center for Superconductivity at the University of Houston, with Prof. Zhifeng Ren being his adviser. His current research interests focus on designing high-performance thermoelectric materials and understanding their intrinsic physical properties.

11:00 –11:15 **Mr. David Waligo**, Ph.D. student, Physics (Prof. Oomman Varghese, adviser)

Role of Scattering in the Prediction of Simulation Based Optical Properties of Dielectric TiO_2 Nanotubular Materials

Understanding light-semiconductor interaction is critical for the development of absorbers for efficient solar energy to electrical or chemical energy (fuel) conversion. Numerical simulation methods are often used to support experimental results and explain various optical phenomena in materials. Finite Difference Time Domain (FDTD) method has emerged as a tool for simulating and modelling different materials with unique optical properties (e.g., photonic band gap materials and plasmonic nanostructures). Nonetheless, the method has not been proven effective in yielding an acceptable agreement between simulated optical properties including transmittance and reflectance and the experimental results for polycrystalline nanostructures and thin films. We have solved this problem by accounting for the majority of the scattering that happens in these nanostructured materials. With our method, we could simulate the optical properties of semiconducting films and nanomaterials of different morphologies and dimensions used as absorbers in solar cells and PEC water splitting devices. The results obtained through simulations were in excellent agreement with those determined experimentally. In this presentation, we discuss the details of our model using titania nanotubes as a case study.

David Waligo, Lilly Schaffer, Maggie Paulose, Oomman K. Varghese,*, Nanomaterials and Devices Laboratory, Department of Physics, University of Houston, Houston, TX 77024, USA; Texas Center for Superconductivity, University of Houston, Houston, TX 77204

Bio: Mr. David Waligo is a Ph.D. candidate (3rd year) in the Department of Physics, University of Houston, working under the supervision of Dr. Oomman Varghese. His current research focuses on the use of nanostructured semiconductor gas sensors for early-stage medical diagnosis of diseases like breast cancer. He uses theoretical simulations like Finite Difference Time Domain (FDTD), and Density Functional Theory to understand the microscopic behavior of these nanostructures and explore ways to enhance their performance. He is also a former student of East African Institute of Fundamental Research (EAIFR) in Rwanda – a partner institute of the International Center for Theoretical Physics (ICTP) based in Trieste, Italy.

11:15 –11:30 **Mr. Bhabesh Sarangi**, Ph.D. student, Materials Science & Engineering (Prof. V. Selva, adviser)

Double-Sided RE-$Ba_2Cu_3O_{7-\delta}$ Tapes by Advanced MOCVD with Critical Current Over 500 A/4mm at 20 K, 20 T

The High Temperature Superconducting (HTS) Coated Conductors (CCs) based on epitaxial $REBa_2Cu_3O_{7-\delta}$ (REBCO, RE = rare earth) films with superior mechanical strength and high current carrying capacity are being developed for use in ultrahigh-field superconducting magnets such as dipoles and quadrupoles for particle accelerators, and for compact fusion. An approach to fabricate double-sided, high-current RE-$Ba_2Cu_3O_{7-\delta}$ (REBCO) tapes for use in ultrahigh-field superconducting magnets operating at and above 20 T is demonstrated. In this work, we modified our advanced metal organic chemical vapor deposition (A-MOCVD) reactor to deposit REBCO films on each side of a double-sided buffer substrate in a single pass. The composition, thickness and critical current of each side double-sided tapes are compared for 1-μm-thick REBCO films. Double-sided REBCO tape with 2 μm thick films on each side showed self-field critical current density (J_c) over 2.6 MA/cm^2 at 77 K and 0 T. 15% Zr doped double-sided REBCO tape showed critical current of 530 A/4mm at 20 K, 20 T which is 3.5x that of commercial REBCO tape performance.

Bio: Mr. Bhabesh Sarangi is a Ph.D. candidate (2nd-year) in the Department of Material Science and Engineering, Cullen College of Engineering, University of Houston, under the supervision of Dr. Venkat Selvamanickam. His research focuses on the fabrication and characterization of High Temperature Superconductor Tapes using Advanced MOCVD. He obtained his Integrated master's degree in physics from the National Institute of Science Education and Research, India.

11:30 – 11:45 **Mr. Chaoshan Wu**, Ph.D. student, Materials Science & Engineering (Prof. Yan Yao, adviser)

Mixed-ionic-electronic-conducting Interlayer Design for High-Performance Solid-State Lithium-Metal Batteries

Solid-state lithium metal batteries have great potential as high energy density and safe energy storage devices, but their performance is limited by the morphological instability of lithium and solid electrolyte interfaces. A mixed-conducting interlayer between Li and SE has been proposed to stabilize the interface, but there is still a lack of comprehensive understanding between interlayer's structure and cell performance. In this study, it was found that Ag particle self-aggregation leads to solid-electrolyte pellet cracking and Li filament formation during cell charging, which is eliminated by embedding Ag on carbon nanoparticles during mixture of Ag-C composite. Evenly distributed Ag nanoparticles were more likely to form percolation pathways during lithiation, enhancing the capability of Li transport through the interlayer and boosting the rate-performance of Li-metal solid-state batteries.

Chaoshan Wu,[†,1] Lihong Zhao,[†,1,2] Zheng Fan,[*,3] Yan Yao[*,1,2]
[1] Materials Science and Engineering Program and Texas Center for Superconductivity at the University of Houston, University of Houston, 4726 Calhoun Rd, Houston, Texas 77204, USA; [2] Department of Electrical and Computer Engineering, University of Houston, 4726 Calhoun Rd, Houston, Texas 77204, USA; [3] Department of Engineering Technology, University of Houston, Houston, TX 77204, USA. † C.W. and L.Z. contributed equally.

Bio: Mr. Chaoshan Wu is currently a Ph.D. candidate in Dr. Yan Yao's group in the Materials Science and Engineering Program and Texas Center for Superconductivity at the University of Houston. His research focuses on development and Operando characterization of all-solid-state Li-metal batteries. He obtained his BSc degree in Materials Science and Engineering from the Zhejing University of Technology.

11:45 – 12:45 **BBQ Lunch Buffet**

SESSION II

Chair: **Prof. Yan Yao, Electrical & Computer Engineering**

1:10 – 1:25 **Mr. Abhijit Bera**, Ph.D. student, Physics (Prof. Kevin Bassler, adviser)

Decomposition of Anomalous Diffusion in Lévy Walks with Finite Step Duration

Diffusive behavior is normally governed by the Central Limit Theorem (CLT), which states that the displacement $x(t)$ in the limit of large time t has a Gaussian distribution with a width that increases as $t^{1/2}$. However, diffusive behavior that differs from the CLT is found in a wide array of experimental systems. In many cases, the dynamics in these systems can be modeled with non-linearly coupled Lévy Walks that have steps of random duration τ chosen from a probability distribution that decays as $\tau^{-1-\gamma}$ and a velocity in each step of random direction with magnitude proportional to $\tau^{\nu-1}$. The root causes of anomalous diffusive behavior can be identified by decomposing the behavior into three fundamental constitutive effects, each of which are associated with the violation of an assumption of the CLT. We show that the anomalous diffusive behavior produced by coupled Lévy Walks with $\gamma \in (1,2]$ is a complex combination of the three effects that are known respectively as the Joseph, Noah, and Moses effects.

Bio: Mr. Abhijit Bera is a Ph.D. candidate (3rd year) in the Department of Physics, NSM, University of Houston under the supervision of Professor Kevin E. Bassler. His research focuses on the decomposition of anomalous diffusion in Lévy Walks. He obtained his integrated BS-MS degree in Physics from the Indian Institute of Science Education and Research, Kolkata.

1:25 – 1:40 **Mr. Jacob Hickey**, Ph.D. student, Chemistry (Prof. Jakoah Brgoch, adviser)

The Limits of Proxy-Guided Superhard Materials Screening

Extensive effort has gone into discovering new hard and superhard materials. One widely employed approach relies on a priori screening using proxies for Vickers microhardness (H_v) obtained from density functional theory (DFT) calculations. Indeed, several semiempirical equations have been proposed to predict H_v solely using the DFT-generated bulk and shear moduli. Yet, hardness is a complex phenomenon influenced by many factors across multiple length scales, constraining the dependability of these approaches. Each DFT "hardness" calculation also claims to be the most accurate, although a comprehensive comparison among the models is rarely performed. Moreover, none of the models capture the observed load dependency of Vickers hardness measurements. This work evaluates the limits of these moduli-derived hardness calculations by examining a robust set of load-consistent, experimental hardness measurements, computationally estimating H_v values of 307 unique compounds, and building a machine learning model capable of predicting H_v. The resulting analysis was then benchmarked against six experimentally synthesized boride systems with diverse crystal chemistries. In all cases, the DFT proxies quickly break down, whereas the machine learning model proves the most accurate for predicting H_v at a significantly lower computational cost. These findings highlight the challenges of using DFT-based semiempirical hardness equations while reinforcing the power of machine learning for hard and superhard materials discovery.

Bio: Mr. Jacob Hickey is currently a 4th year Ph.D. candidate in Dr. Jakoah Brgoch's group in the Department of Chemistry and Texas Center for Superconductivity at the University of Houston. He received his B.S. and M.S. degrees in Chemistry at San Jose State University. His research involves using a combined approach of experimental and computational-based methods to discover new hard materials.

1:40 – 1:55 **Mr. Daniel J. Schulze**, M.S. student, Physics (Prof. Paul C. W. Chu, adviser)

Magnetism and Superconductivity in Kagome $CeRu_2$ at Megabar Pressures

The kagome lattice structure (a trihexagonal pattern) was first predicted in 1951 by Ichirō Shōji. In 1958 some of the first experimental studies on kagome lattice containing $CeRu_2$ were done by B. T. Matthias and colleagues. In the past 60 years since these initial measurements, many theories (reentrant superconductivity vs. a Fulde–Ferrell–Larkin–Ovchinnikov (FFLO) state) have been proposed to explain the interesting phenomena which arise in $CeRu_2$. At ambient pressure, $CeRu_2$ orders magnetically at ~ 40 K and shows a superconducting transition temperature (T_c) at ~ 6 K. We studied the magnetic ordering and superconducting properties of $CeRu_2$ under pressure up to ~ 168 GPa by employing magnetic, resistivity, and structural measurements. Phase transitions will be discussed as well as their implication on the future of $CeRu_2$.

Bio: Mr. Daniel Schulze is a 3rd year Master of Science candidate in the Department of Physics in the College of Natural Sciences and Mathematics at the University of Houston under the supervision of Dr. Paul C. W. Chu. His current work is focused on investigating superconductivity in kagome materials. He obtained his BSc degree in Physics from the University of Texas at Austin.

1:55 – 2:10 **Mr. Surya Pratap Singh Solanki**, Ph.D. student, Chemical & Biomolecular Engineering (Prof. Lars Grabow, adviser)

Dynamically Excited Catalysts with Superior Oxidation Activity

Heterogeneous catalytic cycles involve the adsorption of reactants, followed by one or more activated surface reactions steps before products desorb. The presence of adsorbed reaction intermediates often results in a strong dependence of reaction rates on surface coverages. Furthermore, species with very high binding affinity may become overly abundant and poison the surface. Common examples of coverage sensitive performance are methane and carbon monoxide oxidation on platinum-based catalysts. Excess oxygen inhibits C-H activation and decreases the rate of CH_4conversion, and CO binds so

strongly that it is self-inhibiting during its oxidation to CO_2. To overcome this issue, we are investigating the behavior of catalysts under dynamic conditions which can result in surface coverages that differ from those encountered at steady-state. One approach is the use of modulated feed conditions to unlock surface coverage regimes that are inaccessible under steady-state operation, which has been shown to reduce the light-off temperature for methane oxidation by as much as 100 °C. We are also developing the concept of a "Catalytic Condenser", a device that can manipulate the charge on a catalytic surface and alter adsorption energies or activation barriers at time scales commensurate with the frequency of a catalytic turnover.

Bio: Mr. Surya Pratap Singh Solanki is a Ph.D. candidate (5th-year) in the William A. Brookshire Department of Chemical and Biomolecular Engineering, University of Houston under the supervision of Professor Lars C. Grabow. His research focuses on understanding catalytic properties of metal-based catalyst using both computational and experimental techniques. He is also interested in investigating effect of periodic reaction conditions on the catalyst performance. He obtained his B. Tech degree in Chemical Engineering from the Indian Institute of Technology (IIT)- Roorkee.

2:10 – 2:20 Break / Drawing for Door Prizes

SESSION III Chair: **Prof. Vassiliy Lubchenko, Chemistry**

2:20 – 2:35 **Mr. Minh Dang Nguyen**, Ph.D. student, Chemistry (Prof. T. Randall Lee, adviser)

Tailoring the Size, Shape, and Crystallinity of Iron Oxide Nanoparticles for Studies of Nano-Magnetism and their Potential Applications

The design and fabrication of magnetic iron oxide nanoparticles (IONPs) with desired magnetic properties by tailoring their sizes, shapes, and crystallinity is critical for advancing the field of magnetic nanomaterials and their corresponding applications in biosensing and biomedicine. In this work, we focused on developing synthetic methods capable of producing highly crystalline iron oxide nanospheres (IONSs) having a wide range of sizes (50–390 nm diameters) and controlling their crystallinity without changing their size. The highly crystalline IONSs exhibited markedly enhanced ferrimagnetic (FM) properties, and our ability to control the crystallinity of the IONSs was useful in preparing IONSs with desired properties ranging from ferromagnetism (FM) to superparamagnetism (SPM). In related studies, SPM single crystal IONSs (5–20 nm diameters) were assembled into large super-particles for studies of nano-magnetism with the expectation of unique and potentially useful magnetic behavior.

Bio: Mr. Minh Dang Nguyen is a Ph.D. candidate (4th-year) in the Department of Chemistry, NSM, University of Houston under the supervision of Professor T. Randall Lee. His research focuses on the synthesis of magnetic iron oxide nanoparticles having different sizes and shapes for studies of their magnetic properties for biosensing and biomedicine. He obtained his BSc degree in Advanced Materials Science and Nanotechnology from the University of Science and Technology of Hanoi.

2:35 – 2:50 **Mr. Minghui Ning**, Ph.D. student, Physics (Prof. Zhifeng Ren, adviser)

Direct Alkaline Seawater Electrolysis: Challenges and Solutions

The industrial scale of freshwater electrolysis to produce hydrogen (H_2) will make the shortage of freshwater resource even worse. Seawater, which consists of 97% of the water resource on earth, is much more abundant for water electrolysis. However, the presence of Cl^-, Ca^{2+}, and Mg^{2+} causes several critical problems for the seawater electrolysis. Firstly, the presence of Cl^- introduces chloride oxidation reactions as the competitive reactions for oxygen evolution reaction (OER) at the anode side. The chloride oxidation reactions are undesired since the produced Cl_2 or ClO^- will eventually become

excessive and pollutants to the environment. Secondly, the existence of Ca^{2+} and Mg^{2+} ions will precipitate as $Ca(OH)_2$ and $Mg(OH)_2$ then cause blockages on active sites of catalysts, ion exchange membrane or diaphragm, and the flow channels of electrolyzer. In this presentation, we will introduce the Fe doped Ni&$Ni_{0.2}Mo_{0.8}N$ as highly active and selective seawater electrolysis catalyst. The electrochemically reconstructed Fe, Mo co-doped NiO worked as an efficient alkaline OER catalyst to thermodynamically suppress the chloride oxidation reactions. The Ca^{2+} and Mg^{2+} were removed from seawater via a simple pretreatment to avoid the precipitation of $Ca(OH)_2$ and $Mg(OH)_2$ and achieve the long-term and sustainable seawater electrolysis.

Bio: Mr. Minghui Ning is a Ph.D. candidate (4th year) in the Department of Physics, NSM, University of Houston under the supervision of Professor Zhifeng Ren. His research focuses on the preparation of highly active and selective seawater electrolysis catalysts and the pretreatment of seawater for long-term and sustainable direct seawater electrolysis. He obtained his BSc degree in Science and Technology of Photoelectronics from the South China Normal University.

2:50 – 3:05 **Ms. Mina Moradnia**, Ph.D. student, Mechanical Engineering, (Prof. Jae-Hyun Ryou, adviser)

Single-Crystalline III-N Film Growth for Photonic, Electronic, Sensing, and Energy Harvesting Applications

A combination of desired properties including excellent thermal and chemical stability, low dielectric permittivity, high biocompatibility as well as high dielectric breakdown voltage make III-nitride (III-N) materials unique among other semiconductors and primary candidates for the active area of scientific and technological development. However, the piezoelectric coefficients of III-N materials are relatively low as compared to those of currently dominant piezoelectric materials such as lead zirconate titanate. We introduce a new Hybrid Chemical Vapor (HybCVD) thin film growth method by focusing on transition-metal- alloyed III-V nitride thin films causes significant impact on the enhancement of the piezoelectric properties in group-IIIa-N (III-N) materials such as wurtzite AlN, by group- IIIb transition metals. In addition, a technique has been developed for the growth of crack-free relatively thick AlN and ultrawide-band gap semiconductor materials with a thickness exceeding 1μm. Our focus is on the potential of strain-mediated metal buffer layers to decrease differences in thermal expansion coefficient and lattice mismatch between the template and III-N grown layer. The heteroepitaxial growth of III-N thick film which is missing in the previous studies on the III-N growth is of high demand for performance improvement and cost reduction of III-N based devices simultaneously.

Bio: Ms. Mina Moradnia is a Ph.D. candidate (5th-year) in the Mechanical Engineering Department, University of Houston under the supervision of Professor Jae-Hyan Ryou. Her research focuses on the process development of semiconductor materials and devices with top skills in thin film deposition/growth along with materials characterization/analysis techniques. She published her work in several peer reviewed journal articles and filed patents.

3:05 – 3:20 **Ms. Lilly Schaffer**, Ph.D. student, Physics (Prof. Oomman Varghese, adviser)

Improving the Phase Purity of Nanocrystalline Cu_2SnS_3 Films Fabricated using Solution-Based Precursors for Solar Cell Applications

Copper tin sulfide (CTS), Cu_2SnS_3, is a promising ternary semiconductor for use in photovoltaic cells due to its environmental compatibility, abundance of constituents, high light absorption coefficient, and availability of scalable methods for fabrication. We investigated the evolution of crystalline phase of Cu_2SnS_3 films and dispersed particles using Raman spectroscopy as a function of fabrication conditions and post fabrication treatments. With increasing annealing temperature, the crystalline phase of CTS evolved toward tetragonal, and monoclinic phases. In this presentation, we discuss the conditions to obtain pure monoclinic CTS with reduced impurity concentration and solar cell performance.

Lilly Schaffer[1,2], Maggie Paulose[1], Dhan Rana[1,2], David Waligo[1,2], Nathaly Castaneda Quintero[3], Francisco Robles Hernandez[3] and Oomman Varghese[1,2] [1Nanomaterials and Devices Laboratory, Department of Physics, University of Houston, Houston, Texas 77204; [2]Texas Center for Superconductivity, University of Houston, Houston, Texas 77204. [3]Mechanical Engineering Technology, College Technology, University of Houston, Houston, Texas 77204.]

Bio: Ms. Lilly Schaffer is a 5th year Ph.D. candidate working in the Nanomaterials and Devices Lab in the Department of Physics, and Texas Center for Superconductivity at the University of Houston, under the guidance of Professor Oomman K. Varghese. The focus of her work is on the fabrication of solar cell devices and includes synthesizing copper tin sulfide (CTS) films and investigating the enhancement of light absorption and charge transfer efficiency utilizing nanostructured materials. She completed her undergraduate studies at the University of Houston, where she studied physics, political philosophy, and was active in the Astronomy Society.

3:20 – 3:35 **Ms. Fengjiao Pan**, Ph.D. student, Physics (Prof. Zhifeng Ren, adviser)

Observation of Persistent Hot Carrier Diffusion in Boron Arsenide Single Crystals Synthesized by Chemical Vapor Transport Method

Cubic boron arsenide (c-BAs) is a highly promising material for microelectronics thermal management due to its exceptional thermal conductivity. Furthermore, recent findings have confirmed the high ambipolar mobility in c-BAs samples. Unfortunately, the synthesis of high-quality c-BAs crystals remains a significant challenge, limiting its wide application in industry. In this work, chemical vapor transport (CVT) method is discussed for the synthesis of c-BAs crystals with high quality. In addition, scanning ultrafast electron microscopy (SUEM) is employed to study the time-resolved imaging of photoexcited charge transport in high-quality c-BAs crystals. The hot carrier transport time constant τ (up to 250 ps) extracted from SUEM measurements is significantly longer than that in Si (~ 100 ps on average). It demonstrated that BAs has excellent photocarrier transport properties, in addition to high thermal conductivity and high charge carrier mobility. The combination of desirable optoelectronic and thermal properties of BAs renders it an exciting semiconducting material.

Bio: Ms. Fengjiao Pan is a Ph.D. candidate (4thyear) in the Department of Physics, NSM, University of Houston under the supervision of Professor Zhifeng Ren. Her research focuses on the synthesis of cubic boron arsenide crystals using chemical vapor transport method. She obtained her master's degree in Power Engineering from Shanghai Jiao Tong University.

3:35 p.m. **Closing of Sessions** – Prof. Zhifeng Ren
Deliberation of Judges

3:45 p.m. **Photo of all Presenters** – *Outside, if weather permitting; or HSC 1st Floor Lobby, red wall*

3:55 p.m. **Announcement of Symposium Winners** Zhifeng Ren

4:00 p.m. **Award Presentations & Photo of Prize Winners**
Photos of 2023 – 2024 Scholarship Winners

4:30 p.m. **Closing Remarks** / Drawing for Door Prizes