Houston Community College and the West Houston Center for Science & Engineering Present

The 2018 Research Experiences and Exploration in Materials Science (REEMS)[1]

REU Poster Presentation Program

August 10, 2018
Houston Community College-Northwest
Alief Hayes Campus

[1] Funding for this event is provided by the National Science Foundation, Division of Materials Research 1460564 and the West Houston Center for Science and Engineering General Fund.

The 2018 Research Experiences and Exploration in Materials Science (REEMS) Research Experience for Undergraduates

Poster Presentations & Recognition Ceremony

Program Contents

The 2018 Research Experiences and Exploration in Materials Science (REEMS) Research Experience for Undergraduates

Poster Presentations & Recognition Ceremony
Schedule of Events
August 10, 2018

8:15 – 9:15 am	*Student arrival and poster set-up*
9:00 am	*Judges arrive*
9:45 – 11:30 am	*REU students stand at posters for judging*
Noon – 12:45 pm	*Lunch*
1:00 – 2:30 pm	*Poster Awards and Recognition Ceremony*

REU Site: Research Experiences and Exploration in Materials Science for Houston Community College Science and Engineering Students (REEMS)

NSF REU: Research Experiences and Exploration in Materials Science (REEMS) for Houston Community College Science and Engineering Students

Bartlett (Bart) M. Sheinberg serves as the Principal Investigator for this award.

In 2015, The West Houston Center for Science and Engineering (WHC) was awarded funding from the National Science Foundation to develop an innovative materials science educational program and summer research program specifically for Houston Community College students.

The REEMS program, inclusive of the REU, provides a series of multidisciplinary learning experiences in chemistry, physics, engineering, the biological sciences, medicine, computational science, economics, and public policy.

REEMS students represent diverse cultural, economic, educational backgrounds and ages. While their backgrounds, academic and career goals may vary, each student has an intense motivation to learn, a willingness to explore new challenges, and a desire to accomplish his or her educational and career goals. The evaluation data gathered to date presents a strong correlation of participation in REEMS with an enhanced appreciation of the content and concepts of basic science, mathematics and engineering courses, and the ability to integrate these concepts to solve problems, whether working in the lab or addressing societal issues.

The 2018 REEMS REU poster session provides the opportunity for each student to share his or her summer research experiences with other students, university faculty, family members, and the public. The following provides an overview of the REEMS student profiles and their research, an overview of each of the REEMS REU research professors who sponsored the REEMS REU students in their laboratories, profiles of the 2018 REEMS REU Program Judges, and recognition of the West Houston staff and West Houston Center Advisory Council.

Profiles of the *2018 REEMS REU Students*

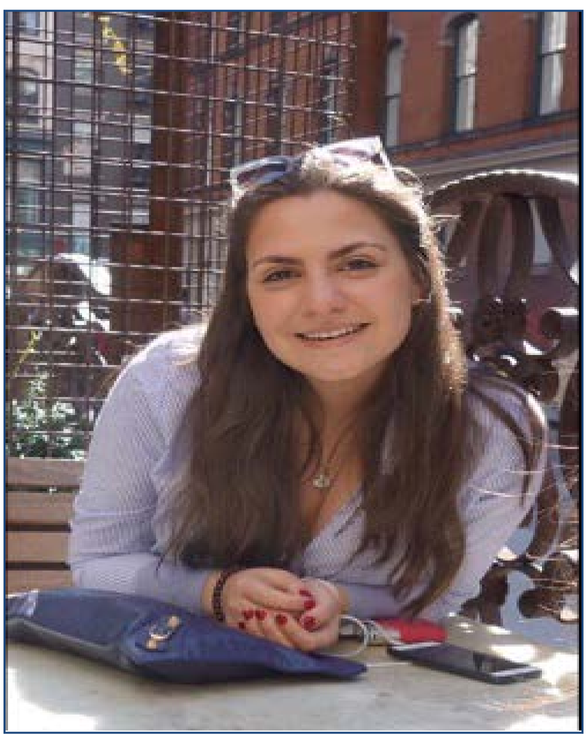
Chiamaka Agu

Transferring in Fall 2018
University of Michigan
Pharmacy

REEMS REU Research Professor
Dr. Rafael Verduzco
Rice University
Department of Chemical &
Biomolecular Engineering

REEMS REU Mentor
Dr. Jorge Mok

Leen Almaasarani



Transferring in Fall 2018
University of Texas Austin
Civil Engineering

REEMS REU Research Professor
Dr. Ming Tang,
Rice University
Department of Materials Science &
NanoEngineering

REEMS REU Mentor
Fan Wang

Edward Armijo

Transferring Fall 2018
University of Houston
Chemical Engineering

REEMS REU Research Professor
Dr. Jakoah Brgoch
University of Houston
Department of Chemistry

REEMS REU Mentor
Shruti Hariyani

Angel Chagolla

Transferring Fall 2018
University of Texas Tyler (HEC)
Mechanical Engineering

REEMS REU Research Professor
Dr. Zachary Cordero
Rice University
Department of Materials Science & NanoEngineering

REEMS REU Mentor
Logan Ware

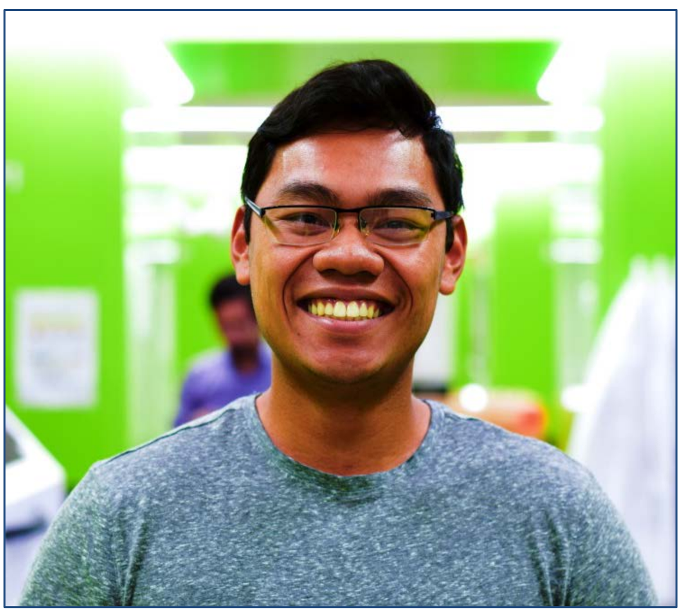
Michael Dean

Transferring 2018
University of Houston
Biology and Computer Science

REEMS REU Research Professor
Dr. Margaret S. Cheung
Rice University Center for Theoretical Biological Physics & University of Houston Department of Physics

REEMS REU Mentor
Aram Davtyan

Jackson Mang



Transfer Fall of 2019
Texas A&M University
Civil Engineering

REEMS REU Research Professor
Dr. Zachary Cordero
Rice University
Department of Materials Science & NanoEngineering

REEMS REU Mentors
Austin Ward
Chris Hareland

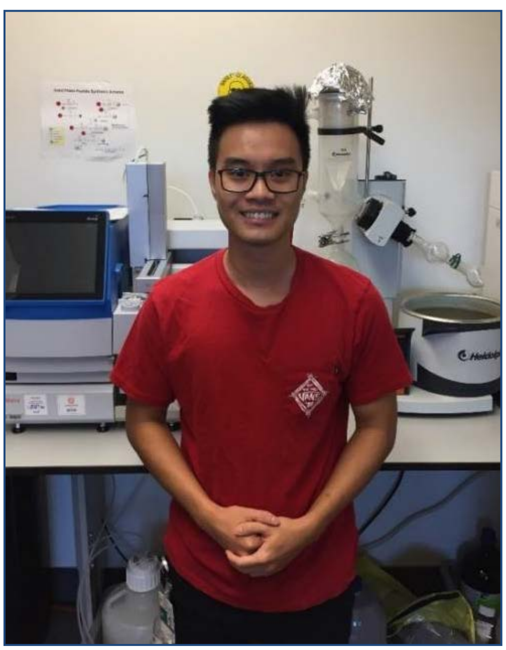
Raul Mora

Transfer Fall 2018
Texas A&M University
Engineering

REEMS REU Research Professor
Dr. Jakoah Brgoch
University of Houston
Department of Chemistry

REEMS REU Mentor
Aria Mansouri Tehrani

Quy Nguyen



Transfer Fall 2018
University of Texas Austin
Mechanical Engineering

REEMS REU Research Professor
Dr. Laura Smith- Callahan
McGovern Medical School
University of Texas Health Science Center
Department of Neurosurgery

REEMS REU Mentor
Dr. Xi Lu

Cristian Oviedo

Transferring Fall 2018
University of Houston
Chemical Engineering

REEMS REU Research Professor
Dr. Megan Robertson
University of Houston
Department of Chemical & Biomolecular Engineering

REEMS REU Mentor
Minjie Shen

Celsa Pachlhofer

Transferring Fall 2019
University of Texas – Tyler (HEC)
Mechanical Engineering

REEMS REU Research Professor
Dr. Ming Tang,
Rice University
Department of Materials Science & NanoEngineering

REEMS REU Mentor
Fan Wang

Tanvi Parikh

Transferring Fall of 2018
University of Houston
Mechanical Engineering

REEMS REU Research Professor
Dr. James K. Meen
University of Houston
Department of Chemistry &
Texas Center for Superconductivity

REEMS REU Mentor
Dr. Karoline Müeller

Mary Pinedo

Transferring Fall 2018
Texas A&M University
Industrial Engineering

REEMS REU Research Professor
Dr. Rafael Verduzco
Rice University
Department of Chemical &
Biomolecular Engineering

REEMS REU Mentor
Dr. Jorge Mok

Lucas Teague

Transfer Fall 2020
The University of Houston
Mathematics
Returning to HCC Fall 2018

REEMS REU Research Professor
Dr. James K. Meen
University of Houston
Department of Chemistry &
Texas Center for Superconductivity

REEMS REU Mentor
Dr. Karoline Müeller

2018 REEMS REU STUDENT ABSTRACTS

2018 REEMS REU STUDENT POSTER PLACEMENTS AND RESEARCH ABSTRACTS

STUDENT NAME	REEMS REU RESEARCH PROFESSOR	POSTER #
Chiamaka Agu & Mary Pinedo	**Rafael Verduzco**	**1**
Leen Almaasarani	**Ming Tang**	**2**
Edward Armijo	**Jakoah Brgoch**	**3**
Angel Chagolla	**Zachary Cordero**	**4**
Michael Dean	**Margaret Cheung**	**5**
Jackson Mang	**Zachary Cordero**	**6**
Raul Mora	**Jakoah Brgoch**	**7**
Quy Nguyen	**Laura Smith-Callahan**	**8**
Cristian Oviedo	**Megan Robertson**	**9**
Celsa Pachlhofer	**Ming Tang**	**10**
Tanvi Parikh	**James Meen**	**11**
Lucas Teague	**James Meen**	**12**

Chiamaka Agu and Mary Pinedo **Poster Number 1**

Fabrication of Flexible Organic photovoltaic devices

Chiamaka Agu.;[1,2] Mary Pinedo.;[1,2] Rafael Verduzco.;[2] Jorge Mok.;[2]

[1]*West Houston Center for Science & Engineering, Houston Community College, MC 1524H*

2811 Hayes Road, Houston, TX 77082

[2]*Department of Chemical and Biomolecular Engineering, Rice University, Houston,Texas*

Organic photovoltaic (OPV) devices harvest energy from solar radiation and produce electricity that can be used for a variety of applications. As opposed to rigid silicon-based solar cells, OPVs can be inexpensively processed and designed to be portable and flexible. However, current flexible OPV devices degrade rapidly under mechanical deformations such as bending or stretching, and a methodology for fabricating robust, fully flexible OPVs is lacking. Here, we developed procedures for fabricating fully flexible OPV devices on flexible substrates polydimethylsiloxane (PDMS) and polyethylene naphthalate (PEN) and compared their performance to devices fabricated on glass. Conventional devices fabricated on indium tin oxide (ITO)-coated glass in an inverted configuration of: glass/ITO/P3HT:PCBM/PEDOT:PSS/Ag exhibited an average power conversion efficiency (PCE) of 2.28% with a short-circuit current (J_{SC}) of 9.57mA/cm^2 and an open-circuit voltage (V_{OC}) of 0.49V. Devices were fabricated on PDMS with a normal configuration of PDMS/PEDOT:PSS/P3HT:PCBM/Al4O83/EGaIn and exhibited an average PCE of 1.28% with a J_{SC} of 9.60mA/cm^2 and a V_{OC} of 0.48V. The poorer performance on PDMS was attributed to lower conductivity of the electrode (PEDOT:PSS). OPV devices on PEN were fabricated with an inverted configuration of PEN/ITO/P3HT:PCBM/Ag and exhibited an average PCE of 0.22% with a J_{SC} of 4.75mA/cm^2 and a V_{OC} of 0.13V. Interlayer annealing temperatures for the ITO-glass and PDMS were approximately 150°C and 180°C respectively but lowered to 120°C for the PEN substrate because high interlayer annealing temperatures resulted in a structural deformation of the PEN substrate. We attribute the poor performance on PEN to unoptimized processing procedures, and we hypothesize that PEN can combine the performance of conventional devices with substrate flexibility. This work demonstrates a viable approach to fully flexible OPV devices, and future work will generalize this approach to high-performance OPV devices.

This research was supported by the National Science Foundation (DMR 1460564)

Fabrication of Flexible Organic Photovoltaic Devices

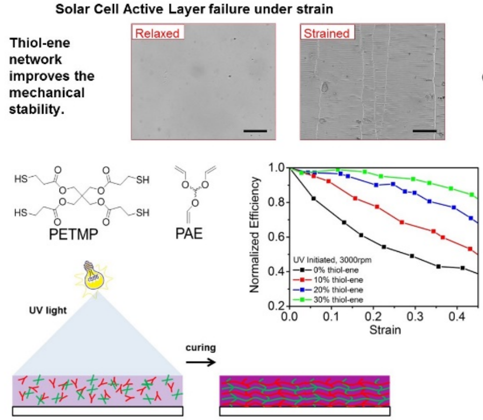
Mary Pinedo[1,2], Chiamaka Agu[1,2], Jorge Mok[2], Rafael Verduzco[2]

[1]REU: REEMS Program, Houston Community College, Houston, TX, USA
[2]Department of Chemical and Biomolecular Engineering, Rice University, Houston, TX, USA

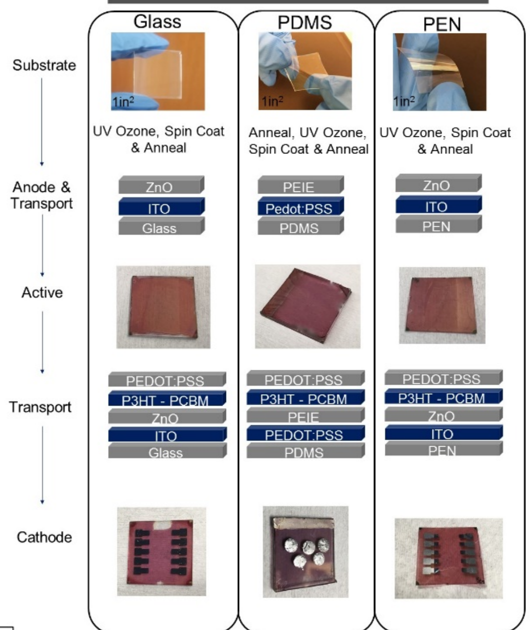
Flexible Organic Photovoltaics

Organic photovoltaic (OPV) devices harvest energy from solar radiation and produce electricity that can be used for a variety of applications. As opposed to rigid silicon-based solar cells, OPVs can be inexpensively processed and designed to be portable and flexible. However, current flexible OPV devices degrade rapidly under mechanical deformations such as bending or stretching, and a methodology for fabricating robust, fully flexible OPVs is lacking. Here, we developed procedures for fabricating fully flexible OPV devices on flexible substrates polydimethylsiloxane (PDMS) and polyethylene naphthalate (PEN) and compared their performance to devices fabricated on glass. A series of OPV devices with an active layer comprised of poly(3-hexylthiophene) (P3HT) donor and phenyl C_{61} butyric acid methyl ester (PCBM) acceptor were fabricated and tested, and our results show that functional devices can be fabricated on both PDMS and PEN but further optimization is required to produce devices with comparable performance to those on glass.

Flexible Active Layer for OPVs

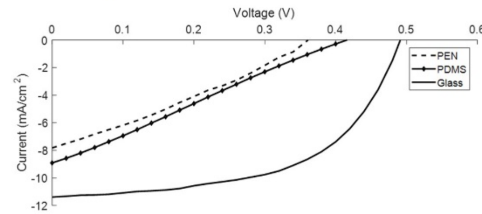


Fabrication on Different Substrates



Solar Device Testing

	Glass	PDMS	PEN
Efficiency (%)	2.28	0.58	0.22
Fill Factor (%)	47.68	29.01	26.96
Short circuit current (mA/cm²)	9.57	4.82	4.75
Open circuit voltage (V_{oc}) (V)	0.49	0.43	0.13



Discussion

- Poor performance of PDMS devices is attributed to the poor conductivity of the PEDOT:PSS electrodes
- Poor performance of PEN devices is attributed to the ZnO charge transport layer. Lower annealing temperatures were used during formation of ZnO layer to minimize substrate bending, and we hypothesize that further optimization will enable devices with performance comparable to glass devices.
- Device performance improved over time for most samples. This is attributed to oxygen doping which can improve charge transport.
- PEN devices offer the best opportunity for combining the flexibility of PDMS with the performance of glass devices.

Future Works

- Optimize the fabrication process on PEN substrate, in particular the deposition of ZnO charge transport layer
- Fabricate fully flexible OPV devices by incorporating thiol-ene network in the active layer
- Extend this fabrication approach to high performance OPV devices

Acknowledgments

We acknowledge the support of the National Science foundation through the REEMS REU program (DMR 1460564). We acknowledge the support of Mr. Bart Sheinberg. We acknowledge the support of the Verduzco laboratory and access to equipment provided by the Shared Equipment Authority at Rice University.

References

1. Lipomi & Bao. "Stretchable and ultraflexible organic electronics." *MRS Bull.*, **2017**, *42* (2), pp. 93-97
2. Serap et al. "Conjugated Polymer-Based Organic Solar Cells." *Chem. Rev.*, **2007**, *107* (4), pp 1324–1338

Leen Almaasarani **Poster Number 2**

Synthesis of High Quality Single Crystalline $LiCoO_2$ Battery Electrode Particles Using the Flux Method

Leen Almaasarani [1], Fan Wang [2], Ming Tang [2]

[1] REEMS REU Program, The West Houston Center for Science & Engineering, Houston Community College, Houston TX
[2] Department of Material Science and Nano-Engineering at Rice University, Houston TX

Lithium-ion rechargeable batteries (LIBs) are the main power source for electrical vehicles but their energy density, life and cost still need to be further improved to enable their wider adoption. Electrode particles in current commercial LIB are usually aggregates of a large number of small primary particles, which are known as secondary particles. Their complex internal structure complicates the observation and understanding of the fundamental physical phenomena during battery cycling such as lithium transport and phase transformations, which are essential to the development of better electrode materials. Furthermore, the large number of defects such as pores and grain boundaries inside the secondary particles are often sources of mechanical and chemical degradation. The objective of this study is to synthesize high-quality single crystalline electrode particles using the flux method, which is a versatile, environmentally friendly, simple and low-cost synthesis technique for growing microsized single crystals at temperatures in melted flux (or molten salt) environment. Layered lithium cobalt oxide ($LiCoO_2$), which is the most widely used cathode material for LIBs, is chosen as the model system. We systematically investigate the effects of various synthesis variables on the morphology, structure and electrochemical properties of $LiCoO_2$ particles. These variables include the type of flux (NaCl, KCl, Na_2SO_4), the molar ratio of the reactants ($LiOH:Co_3O_4$:flux), baking temperature and time. The obtained particles are characterized by scanning Electron Microscopy (SEM), X-Ray diffraction (XRD) and galvanostatic cycling experiments. It became evident that the crystals grow best at two baking steps - 500°C for 5 hours then 800°C for an additional 5 hours. However, further examination will determine the precise chemical and physical conditions that will allow the growth of high quality single crystals.

Synthesis of High Quality Single Crystalline $LiCoO_2$ Battery Electrode Particles Using The Flux Method

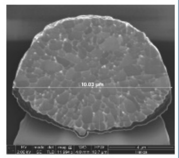
Leen Almaasarani [1], Fan Wang [2], Ming Tang [2]

[1] REEMS REU Program, The West Houston Center for Science & Engineering, Houston Community College, Houston TX

[2] Department of Material Science and Nano-Engineering at Rice University, Houston TX

1- Introduction

Lithium-ion rechargeable batteries (LIBs) are the main power source for electrical vehicles but their energy density, life and cost still need to be further improved to enable their wider adoption. Electrode particles in current commercial LIB are usually aggregates of a large number of small primary particles, which are known as secondary particles. Their complex internal structure complicates the observation and understanding of the fundamental physical phenomena during battery cycling such as lithium transport and phase transformations, which are essential to the development of better electrode materials.



Commercial Battery Electrode (Courtesy of Dr. Y.-M. Chiang)

Objective of the Study

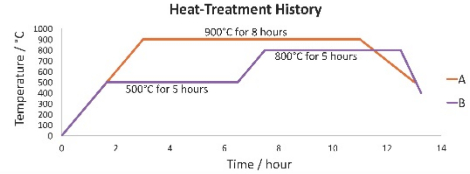
Synthesize high-quality single crystalline electrode particles using the flux method, which is a versatile, environmentally friendly, simple and low-cost synthesis technique for growing micro-sized single crystals at temperatures in melted flux (or molten salt) environment. It has been used to make different cathode material such as LCO, NMC, and LMNO. Layered lithium cobalt oxide ($LiCoO_2$), which is the most widely used cathode material for LIBs, is chosen as the model system.

2- Synthesis of $LiCoO_2$ Crystals

Mix LiOH, Co_3O_4, and Flux → Bake in Furnace → Wash with Deionized Water to remove Flux → Dry in Air-blow oven to get LCO powders

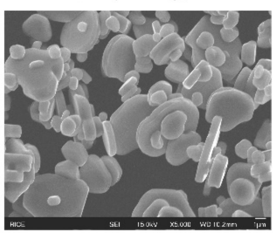
[1,2] We systematically investigate the effect of several critical parameters in synthesis, such as molar ratio, type of flux, baking temperature and time, on the structure morphology and performance of the resulting particles. Out of all the batches, the last four in the following table had the most representative results:

Batch No.	Flux	Li:Co:Flux Ratio	Annealing	Heat-Treatment History
1-6	NaCl Na_2SO_4 KCl	varies	varies	varies
7	Na_2SO_4	1:1:2.5	No	A
8	Na_2SO_4	1.5:1:2.5	No	A
9	KCl	2:1:2	No	B
10	KCl	2:1:2	750°C for 10 hrs	B



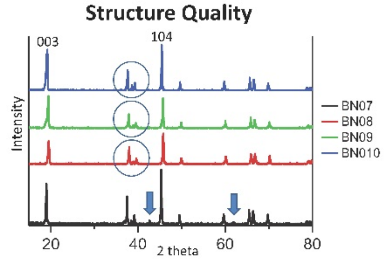
3- SEM, XRD, and Performance Results

Morphology



High magnification Scanning Electron Microscopy (SEM) image of the grown $LiCoO_2$ particles, showing plate-like single crystals with diameters of 2-5 µm and thicknesses less than 1 µm.

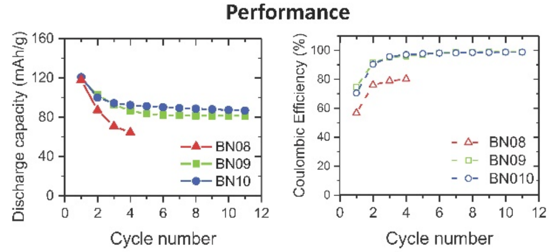
Structure Quality



X-Ray Diffraction (XRD) spectra of as-grown $LiCoO_2$ crystals

- Short peaks indicate that LCO is a crystalline material
- Large 003:104 Ratio indicates ordering in the layered structure
- Presence of splitting (shown in circles) indicates better ordering
- Arrows show impurity peaks in BN07

Performance



- The discharge capacity is 120 mAh/g at first cycle for all batches, which is close to the theoretical capacity of LCO (130 mAh/g).
- The discharge capacity is stabilized at 80 mAh/g for BNO9 and BN10.
- Capacity decay and low Coulombic efficiency indicate the presence of irreversible reactions at the first four cycles.

4- Conclusion

- The molar ratio of Lithium:Cobalt needs to be higher than 1:1, to avoid the insufficient amount of Lithium in the electro-particle due to evaporation.
- A two step baking, starting with a baking temperature lower than the flux melting point then a high baking temperature, produces higher crystal quality and capacity which is potentially due to reduced evaporation of Lithium precursor during synthesis.
- Flux with low melting points allow a lower baking temperature which is beneficial to the electro-particle performance.
- Annealing can provide limited improvement to cycling performance, probably because it relieves internal stress after baking, but it also causes deterioration of the layered structure of LCO.

5- Future Works

- Study the effect of low melting point flux on the structure and performance on the electrode particles
- Determine the effect of annealing on the quality and performance of LCO particles
- Understand how baking time and temperature affect particle size

6- Acknowledgments

I thank the National Science Foundation (DMR-1460564) and Mr. Bart Sheinberg for this research opportunity. I also thank my mentor Fan Wang and Dr. Ming Tang for their support and mentorship during my research experience.

7- References

1. Crystal Growth & Design, Vol. 10, No. 10, 2010
2. Crystal Growth & Design, Vol. 7, No. 12, 2007

Edward Armijo **Poster Number 3**

Synthesis and Optical Properties of a Blue Silicate: $Na_2SrSi_2O_6$: Ce^{3+}

Edward Armijo[2], Shruti Hariyani[1], Jakoah Brgoch[1]
[1] Department *of Chemistry,* University of Houston, Houston, TX 77204
[2] Houston Community College, REEMS Program, Houston, Texas

Due to its high efficiency, longer lifetimes, and environmentally friendly composition, solid state lighting (SSL) is quickly replacing fluorescent and incandescent lighting. SSL consists of a near-UV LED chip and an inorganic phosphor which partially down converts the emission from the LED chip into the visible region of the electromagnetic spectrum. Inorganic phosphors are typically composed of a rigid crystal structure substituted with a rare-earth element such as Ce^{3+} or Eu^{2+}. White light is produced by combining three inorganic phosphors (blue, green, and red-emitting) with a near-UV LED. This system can achieve a high color quality white light by correctly blending these three colors. Unfortunately, the large Stokes' shift between phosphor emission and excitation results in lower efficiencies that inhibit potential application in devices. To minimize this inherent loss in efficiency, the three phosphors incorporated into the device must possess a high (>80%) photoluminescent quantum yield (PLQY). One widely studied class of phosphors are silicates because of their large band gaps and excellent thermal and chemical stability. Li_2SrSiO_4 is a prime example, emitting yellow light (λ_{em}= 585 nm) when substituted with Ce^{3+} with a high thermal stability of 552 K. In this work, the substitutional derivative $Na_2SrSi_2O_6$:Ce^{3+} was made via conventional high temperature solid state synthesis. Photoluminescent measurements show that, when excited with λ_{ex} = 352nm light, $Na_2SrSi_2O_6$:Ce^{3+} produces a blue emission ($\lambda_{max,em}$ = 439 nm) but a room temperature PLQY of approximately 3%. Temperature dependent luminescent measurements show that $Na_2SrSi_2O_6$:Ce^{3+} loses half of its emission intensity at 223 K. Therefore, before this material can be incorporated into a device, the thermal stability and efficiency must be improved.

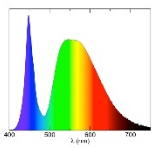
This research was funded by the National Science Foundation (DMR 1460564)

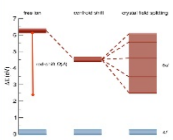
Synthesis and Optical Properties of a Blue Silicate: $Na_2SrSi_2O_6$: Ce^{3+} for Application in Solid State White Lighting

Edward Armijo, Shruti Hariyani, Jakoah Brgoch
Department of Chemistry, University of Houston, Houston, TX 77204

Introduction to Solid State Lighting

Advantages to Solid State Lighting:
- Higher efficiency
- Longer lifetimes
- Environmentally friendly[1]





Solid state lighting combines a phosphor with a UV LED to produce a white light.

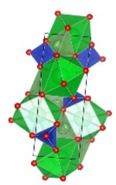
A phosphor is composed of a rigid crystal structure doped with a rare-earth luminescent center, usually Ce^{3+} or Eu^{2+}.

The rare-earth causes crystal field splitting; the 4f and 5d orbitals become close enough to emit photons in the visible spectrum.

One widely studied-class of phosphors are silicates due to the large band gap, good thermal quenching, and excellent chemical stability.

One example is Li_2SrSiO_4 which luminesces bright yellow (λ_{em}= 585 nm).

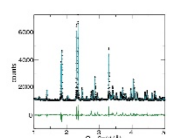
Substitutional derivatives of Li_2SrSiO_4 was searched for similar properties.



Crystal structure of Li_2SrSiO_4

Synthesis and Structure

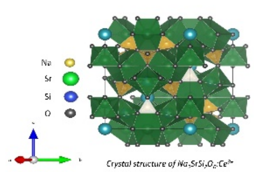
The $Na_2SrSi_2O_6$:Ce^{3+} phase was made by combining $NaHCO_3$, $SrCO_3$, SiO_2, and CeO_2 in stoichiometric ratios at 990°C under reducing conditions for 12 hours.



Refinement of $Na_2SrSi_2O_6$:Ce^{3+}

Sample was confirmed pure by refinement of powder x-ray diffraction data.

$Na_2SrSi_2O_6$:Ce^{3+} is trigonal and belongs to the R$\bar{3}$m space group. Within the structure, there is site mixing with 33% Na and 67% Sr.

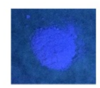


Crystal structure of $Na_2SrSi_2O_6$:Ce^{3+}

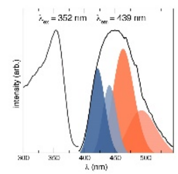
Photoluminescent Excitation/Emission

$Na_2SrSi_2O_6$:Ce^{3+} luminesces light blue.

$Na_2SrSi_2O_6$:Ce^{3+} has two luminescent centers, leading to two separate Ce^{3+} emission peaks.

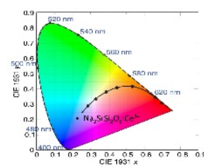


Luminescence of $Na_2SrSi_2O_6$:Ce^{3+} λ_{ex} = 365 nm



CIE Diagram

The emission spectra were integrated across the tristimulus function, normalized for brightness, and plotted on a 1931 CIE diagram.[2]



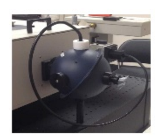
By plotting on the CIE, the emission is transformed into the visible spectrum. $Na_2SrSi_2O_6$:Ce^{3+} luminescence a light shade of blue.

Photoluminescent Quantum Yield

Efficiency is determined via photoluminescent quantum yield (PLQY) which measures the ratio of photons emitted over photons absorbed.

PLQY measurements are taken using a full integrating sphere system that is coated with spectralon, a highly reflective fluoropolymer.

The average PLQY of $Na_2SrSi_2O_6$:Ce^{3+} is 2.98%. This is an incredibly low quantum yield could be due to intense thermal quenching at room temperature.



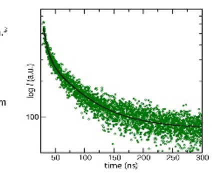
Full integrating sphere system

Luminescent Lifetime

Lifetime is the average length of time a molecule stays in its excited state before emitting a photon.[3]

It is fit using: $I = A_1e^{(-t/\tau_1)} + A_2e^{(-t/\tau_2)}$

The lifetime of $Na_2SrSi_2O_6$:Ce^{3+} when λ_{ex} = 352 nm is:
- T_1=57.22 ns
- T_2= 6.74 ns



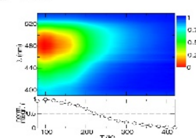
These lifetimes are characteristic of cerium doped phosphors.

Thermal Stability

LED's normally operate at temperatures greater than 400K.

Thermal stability is described by a compound's T_{50}, the temperature at which the intensity of luminescence is half the original intensity.

The T_{50} for $Na_2SrSi_2O_6$:Ce^{3+} is
225 K when λ_{ex} = 352 nm



Thermal contour plot; λ_{ex} = 352 nm

Conclusions and Future Work

$Na_2SrSi_2O_6$:Ce^{3+}, a substitutional derivative of Li2SrSiO4, crystalizes in a R$\bar{3}$m space group.

When excited by λ_{ex} = 352 nm, $Na_2SrSi_2O_6$:Ce^{3+} luminesces blue. Unfortunately, due to extreme thermal quenching and low efficiency, $Na_2SrSi_2O_6$:Ce^{3+} is not suitable in devices at this time.

In order to improve the properties of $Na_2SrSi_2O_6$:Ce^{3+}, smaller isovalent atoms such as Ca^{2+} will be substituted into the lattice structure in hopes of improving the T_{50}. In addition, $Na_2CaSi_2O_6$ will also be attempted to be synthesized.

References and Acknowledgements

The authors thank the Department of Chemistry and the Division of Research at the University of Houston for providing start-up funds. The authors thank the HCC REEMS REU program. This work was also supported by the R. A. Welch Foundation, the State of Texas through the Texas Center for Superconductivity, and NSF DMR 1460564.

[1] N. C. George, K. A. Denault and R. Seshadri, Ann. Rev. Mater. Res., 2013, 43, 481-501.
[2] Kwang Bok Kim,*,†, Yong Il Kim,‡, Hui Gon Chun,§, Tong Yul Cho,§, Jae Sun Jung,∥ and, and Jun Gill Kang*,∥ Chemistry of Materials 2002 14 (12), 5045-5052
[3] E. Finley, A. S. Paterson, A. Cobb, R. C. Willson, and J. Brgoch Opt. Mater. Express, 2017, 7, 2597–2616.

UNIVERSITY of HOUSTON | CHEMISTRY

Hybrid Advanced Manufacturing Techniques for Single Grain Boundary Fabrication & Study

Hybrid Advanced Manufacturing Techniques for Single Grain Boundary Fabrication &Study

Angel Chagolla[1], Logan Ware[2], Zachary Cordero[2]

[1] REEMS REU Program, The West Houston Center for Science & Engineering, Houston Community College, Houston TX

[2] Department of Materials Science and Nano Engineering at Rice University, Houston TX

Grain boundaries are two dimensional interfaces between two grains with different crystal orientation in a polycrystalline material. The structure of the grain boundaries and the grain boundary network in a material are a major influence on the observed macroscopic properties. However, grain boundaries are complex, requiring advanced experimental and statistical techniques to study. We have developed a hybrid manufacturing technique which leverages multiple advanced and traditional manufacturing techniques to create bicrystals, two single crystals which meet at a unique grain boundary. The technique involves three stages: investment casting using additively manufactured bicrystal positives, directional solidification, and CNC milling. This high throughput technique can quickly and efficiently create a statistically significant number of identical grain boundary samples with minimal post processing steps. We demonstrate this process using nominally pure aluminum to create samples for *in situ* observations of grain boundary deformation behavior under hyper velocity shock.

This work is supported by the National Science Foundation (DMR-1460564) and the Houston Community College District.

Hybrid Advanced Manufacturing Techniques for Single Grain Boundary Fabrication & Study

Angel Chagolla[1], Logan Ware[2], Zachary Cordero[2]
[1] REEMS REU Program, Houston Community College, Houston TX
[2] Department of Materials Science and NanoEngineering, Rice University, Houston TX

Background

Metallic solidification

- Solid grains of uniform crystal structure nucleate throughout the liquid metal
- Grains grow in size until their surfaces meet, forming grain boundaries with random characteristics

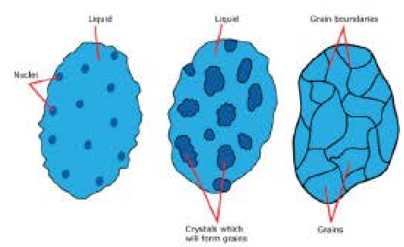


Figure 1. Schematic illustrating the three step process of omnidirectional solidification in metals: nucleation, growth, and formation of grain boundaries.

Directional solidification and grain boundary control

- Mold filled with liquid metal is slowly removed from a furnace
- Single grains nucleate on one end and grow in size until they meet in a single grain boundary
- Full control & manipulation of all 5 grain boundary degrees of freedom, as well as position
- The relationship between grain boundary structure and its properties can be studied quickly and efficiently

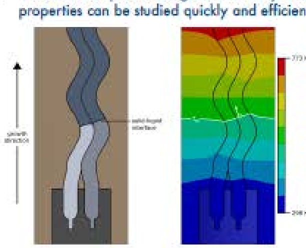


Figure 2. Schematic of directional solidification in a complex bicrystal, along with finite element simulation of the temperature profile within the mold and crystal melt. The growth direction is indicated on the left, while the isothermal contour corresponding to the melting point of tin is shown in the simulation.

Bicrystal growth using additive manufacturing

Stage 1:
Mold making process using stereolithography

Bicrystals are made using a mold making process similar to lost wax casting, replacing wax patterns with plastic patterns made using stereolithography, an additive manufacturing process which forms solid polymers from a liquid photopolymer bath using a laser. Composite molds are made using zirconia-based shell molds with a plaster of Paris backing for added stability to prevent mold cracking. The 3D printed positive pattern is then burned out using a furnace, forming a mold cavity with high resolution.

Stage 2:
Casting and directional solidification

Molten aluminum is cast into the mold. The mold assembly is inserted into a vacuum Bridgman furnace, which reduces the pressure in the furnace to ~5 Pa. The furnace is heated to 1023 K, then slowly raised up at 1.27 cm/hr until the bicrystal is solidified. This high temperature and slow speed ensures that the grains seeded at the bottom of the mold grow continuously without interference from extra grains nucleating and growing.

Stage 3:
Sample preparation using advanced manufacturing

Multiple samples are extracted from the specimen by CNC milling, which limits microstructural damage under the surface and automates sample preparation. To remove material and reduce the size to the desired dimensions, the samples are electropolished using a solution of phosphoric acid, ethanol, and water.

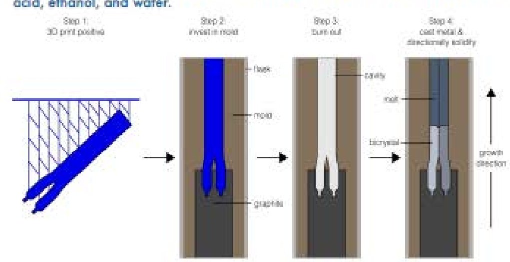


Figure 3. Schematic showing the mold making process, which corresponds to Step 1 and Step 2 of the three step process

Results & Conclusion

Examples of the grown bicrystals and final samples are shown in Figure 4. Crystallographic data confirms each of these samples as bicrystals with flat grain boundaries in the center of each sample. This is a successful demonstration of the hybrid advanced manufacturing technique for both scientific study and engineering application.

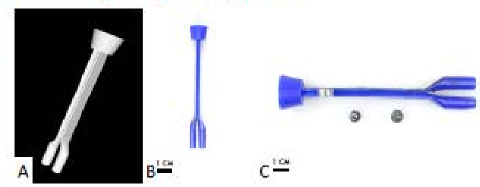


Figure 4. Bicrystal schematic, plastic positive, and final samples extracted from the aluminum bicrystal. (A) Computer model of the bicrystal geometry. (B) Optical photograph of plastic positive printed using SLA before the mold making process. (C) Optical photograph of both the SLA pattern and three samples, each containing a single grain boundary, extracted from aluminum bicrystal via CNC milling. Both scale bars represent 1 cm.

Future Work

- Samples produced in this work are under examination and study at the United States Army Research Laboratory. *In situ* studies are being conducted on the samples, which are subjected to hyper velocity shock (~8 km/s) while being observed using high speed X-ray imaging. The impact wave response of a single grain boundary will be observed.
- Extend this technique to other grain boundary structure-property relationships, including the dependence on grain boundary structure of grain boundary energy, embrittlement, and tensile strength.

Special Thanks

- The National Science Foundation
- Division of Materials Research 1460564
- Rice University
- Logan Ware &. Dr. Cordero
- The REEMS program at HCCS

References

- Ware, L. G., Suzuki, D. H., Wicker, K. R. & Cordero, Z. C. Grain boundary plane manipulation in directionally solidified bicrystals and tricrystals. *Scripta Materialia* **152**, 98–101 (2018).
- The University of Waikato, via www.sciencelearn.org.nz

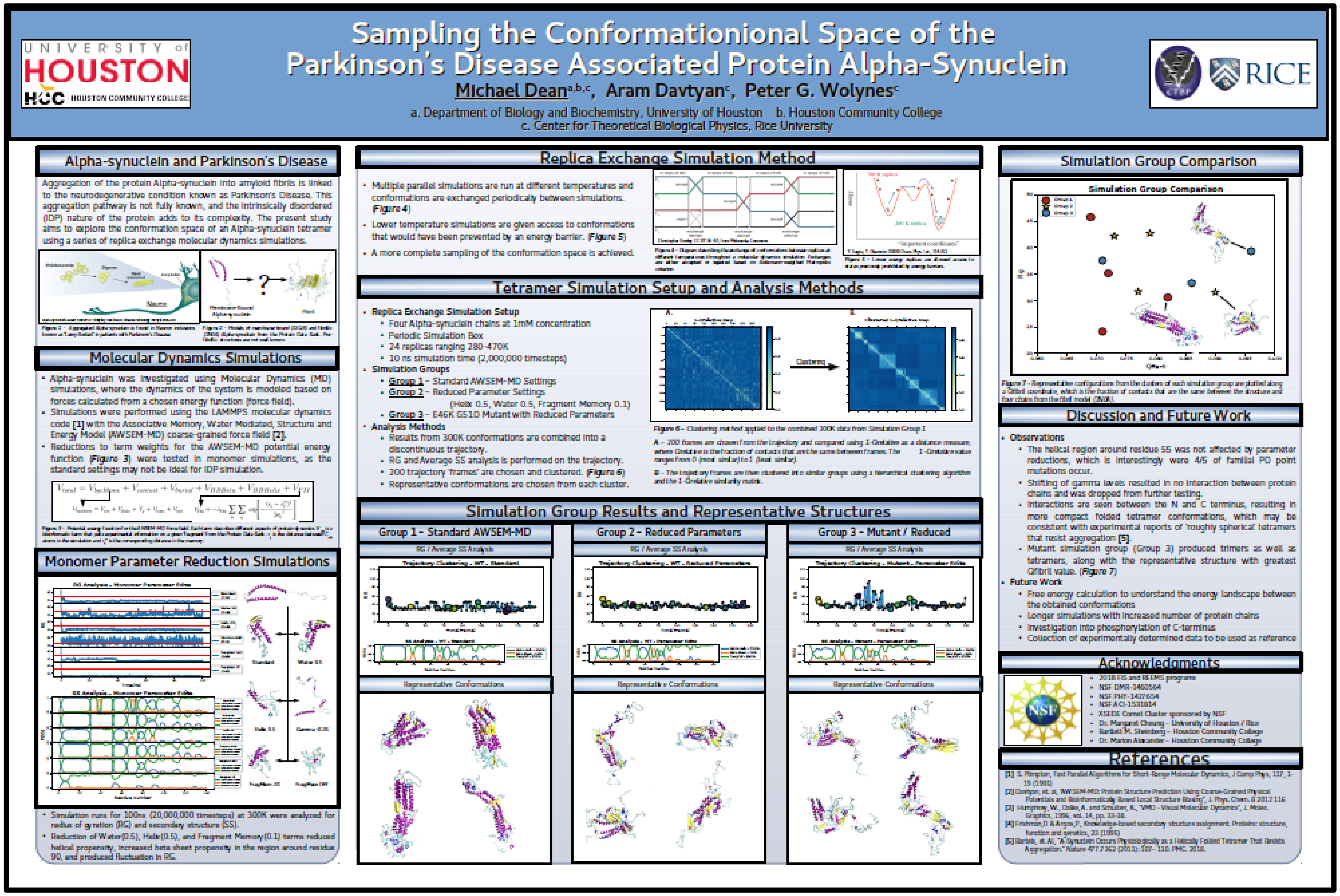
Sampling the Conformational Space of the Parkinson's Disease Associated Protein Alpha-Synuclein

Michael Dean[a,b,c], Aram Davtyan[c], Garegin A. Papoian[d], and Peter G. Wolynes[c]

a. REEMS Program, Houston Community College b. Department of Biology and Biochemistry, University of Houston c. Center for Theoretical Biological Physics, Rice University d. Department of Chemistry and Biochemistry, University of Maryland

Aggregation of the protein Alpha-synuclein into amyloid fibrils is linked to the neurodegenerative condition known as Parkinson's Disease. This aggregation pathway is not fully understood, and the intrinsically disordered (IDP) nature of the protein adds to its complexity. In the present study, the conformational space of Alpha-synuclein was explored for both monomers and tetramers using the computational method of Molecular Dynamics (MD) simulations, along with the Associative Memory, Water Mediated, Structure and Energy Model (AWSEM-MD), a coarse-grained model for globular proteins. To optimize AWSEM-MD for IDP dynamics, modifications to the parameters of the model were tested in a series of monomer simulations. From these, a suitable set of parameters were chosen based on analysis of protein radius of gyration and secondary structure. Tetramer simulations were run with four Alpha-synuclein chains using enhanced sampling techniques under three conditions: standard AWSEM-MD parameter values, modified parameter values selected from the previous monomer simulations, and an additional modified parameter group with two point mutations associated with familial Parkinson's Disease. Trajectories from the tetramer simulations were analyzed for radius of gyration and secondary structure, and representative conformations were selected through clustering analysis. Tetramers were observed showing interactions between the C and N termini resulting in a variety of structural states, with the most compact states potentially resembling an experimentally reported spherical tetramer that resists aggregation. Parameter modification produced the greatest average beta sheet propensity, and a trimer conformation with a free monomer was observed in the familial mutant group. Continued work will include collection of experimental reference data, free energy calculations, additional simulations for higher level oligomers, and investigation into the effect of C-terminus phosphorylation.

This work is supported by the National Science Foundation (NSF DMR 1460564).


Sampling the Conformationional Space of the Parkinson's Disease Associated Protein Alpha-Synuclein
Michael Dean[a,b,c], Aram Davtyan[c], Peter G. Wolynes[c]
a. Department of Biology and Biochemistry, University of Houston b. Houston Community College
c. Center for Theoretical Biological Physics, Rice University
UNIVERSITY of HOUSTON
HCC HOUSTON COMMUNITY COLLEGE
RICE
Alpha-synuclein and Parkinson's Disease
Aggregation of the protein Alpha-synuclein into amyloid fibrils is linked to the neurodegenerative condition known as Parkinson's Disease. This aggregation pathway is not fully known, and the intrinsically disordered (IDP) nature of the protein adds to its complexity. The present study aims to explore the conformation space of an Alpha-synuclein tetramer using a series of replica exchange molecular dynamics simulations.
Neuron
Membrane Bound Alpha-synuclein
Fibril
Molecular Dynamics Simulations
Alpha-synuclein was investigated using Molecular Dynamics (MD) simulations, where the dynamics of the system is modeled based on forces calculated from a chosen energy function (force field).
Simulations were performed using the LAMMPS molecular dynamics code [1] with the Associative Memory, Water Mediated, Structure and Energy Model (AWSEM-MD) coarse-grained force field [2].
Reductions to term weights for the AWSEM-MD potential energy function (Figure 3) were tested in monomer simulations, as the standard settings may not be ideal for IDP simulation.
Monomer Parameter Reduction Simulations
Simulation runs for 100ns (20,000,000 timesteps) at 300K were analyzed for radius of gyration (RG) and secondary structure (SS).
Reduction of Water(0.5), Helix(0.5), and Fragment Memory(0.1) terms reduced helical propensity, increased beta sheet propensity in the region around residue 90, and produced fluctuation in RG.
Replica Exchange Simulation Method
Multiple parallel simulations are run at different temperatures and conformations are exchanged periodically between simulations. (Figure 4)
Lower temperature simulations are given access to conformations that would have been prevented by an energy barrier. (Figure 5)
A more complete sampling of the conformation space is achieved.
Tetramer Simulation Setup and Analysis Methods
Replica Exchange Simulation Setup
Four Alpha-synuclein chains at 1mM concentration
Periodic Simulation Box
24 replicas ranging 280-470K
10 ns simulation time (2,000,000 timesteps)
Simulation Groups
Group 1 – Standard AWSEM-MD Settings
Group 2 – Reduced Parameter Settings (Helix 0.5, Water 0.5, Fragment Memory 0.1)
Group 3 – E46K G51D Mutant with Reduced Parameters
Analysis Methods
Results from 300K conformations are combined into a discontinuous trajectory.
RG and Average SS analysis is performed on the trajectory.
200 trajectory 'frames' are chosen and clustered. (Figure 6)
Representative conformations are chosen from each cluster.
Clustering
Figure 6 – Clustering method applied to the combined 300K data from Simulation Group 1
A – 200 frames are chosen from the trajectory and compared using 1-Qrelative as a distance measure, where Qrelative is the fraction of contacts that are the same between frames. The 1-Qrelative value ranges from 0 (most similar) to 1 (least similar).
B – The trajectory frames are then clustered into similar groups using a hierarchical clustering algorithm and the 1-Qrelative similarity matrix.
Simulation Group Results and Representative Structures
Group 1 – Standard AWSEM-MD
Group 2 – Reduced Parameters
Group 3 – Mutant / Reduced
RG / Average SS Analysis
Representative Conformations
Simulation Group Comparison
Figure 7 - Representative configurations from the clusters of each simulation group are plotted along a Qfibril coordinate, which is the fraction of contacts that are the same between the structure and four chains from the fibril model (2N0A).
Discussion and Future Work
Observations
The helical region around residue 55 was not affected by parameter reductions, which is interestingly were 4/5 of familial PD point mutations occur.
Shifting of gamma levels resulted in no interaction between protein chains and was dropped from further testing.
Interactions are seen between the N and C terminus, resulting in more compact folded tetramer conformations, which may be consistent with experimental reports of 'roughly spherical' tetramers that resist aggregation [5].
Mutant simulation group (Group 3) produced trimers as well as tetramers, along with the representative structure with greatest Qfibril value. (Figure 7)
Future Work
Free energy calculation to understand the energy landscape between the obtained conformations
Longer simulations with increased number of protein chains
Investigation into phosphorylation of C-terminus
Collection of experimentally determined data to be used as reference
Acknowledgments
2018 FIS and REIMS programs
NSF DMR-1460564
NSF PHY-1427654
NSF ACI-1531814
XSEDE Comet Cluster sponsored by NSF
Dr. Margaret Cheung – University of Houston / Rice
Bartlett M. Sheinberg – Houston Community College
Dr. Marion Alexander – Houston Community College
References
[1] S. Plimpton, Fast Parallel Algorithms for Short-Range Molecular Dynamics, J Comp Phys, 117, 1-19 (1995)
[2] Davtyan, et. al, "AWSEM-MD: Protein Structure Prediction Using Coarse-Grained Physical Potentials and Bioinformatically Based Local Structure Biasing", J. Phys. Chem. B 2012 116
[3] Humphrey, W., Dalke, A. and Schulten, K., "VMD - Visual Molecular Dynamics", J. Molec. Graphics, 1996, vol. 14, pp. 33-38.
[4] Frishman,D & Argos,P., Knowledge-based secondary structure assignment. Proteins: structure, function and genetics, 23 (1995)
[5] Bartels, et. Al, "A-Synuclein Occurs Physiologically as a Helically Folded Tetramer That Resists Aggregation." Nature 477.7362 (2011): 107–110. PMC. 2018.

Jackson Mang **Poster Number 6**

Ultrasonic Powder Consolidation of Nanocrystalline Cu

Jackson Mang[1], Austin Ward[2], Chris Hareland[2], Zachary Cordero[2]

[1]REEMS REU Program, the West Houston Center for Science and Engineering, Houston Community College, Houston TX
[2]Department of Material Science and Nano Engineering at Rice University, Houston TX

Nanocrystalline Cu has high strength while maintaining excellent thermal properties, making it ideal for structural applications where heat transport is necessary. However, while there are established techniques for making nanocrystalline Cu powder, it remains a challenge to consolidate this feedstock into bulk components. The primary challenge is that many of the standard consolidation techniques require elevated temperatures that can activate grain growth in nanocrystalline materials. To address this challenge, we have densified nanocrystalline powder feedstock using a low-temperature process termed ultrasonic powder compaction. Ultrasonic powder compaction is similar to uniaxial die compaction, except that the punch also acts as a sonotrode and oscillates perpendicular to the loading axis at ultrasonic frequencies. This shearing motion, when superimposed on a uniaxial compressive stress, has been shown to accelerate powder densification under low applied stresses. In this work, we first develop processing-structure-property linkages for ultrasonic powder compaction and then use this understanding to identify parameter sets for densifying nanocrystalline copper powder into fully dense compacts with retained nanostructure.

This work is supported by the National Science Foundation (DMR-1460564) and the Houston Community College District.

Ultrasonic Powder Compaction of Nanocrystalline Copper Powder

Jackson Mang, Austin Ward, Chris Hareland, Zachary Cordero, Rice University

1. Motivation for Ultrasonic Processing

Copper powder that is structured on the nanoscale is much stronger than conventional micro-structured copper. However, most techniques used to consolidate powder into dense components rely on high temperatures that can eliminate nanoscale structure.

2. Ultrasonic Powder Compaction

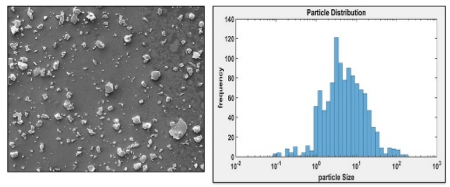
Ultrasonic powder compaction (UPC) is a recently developed powder compaction technique that can produce fully dense compacts without the need for external heating. In UPC, a punch applies a compressive load to the feedstock powder in a die and oscillates perpendicular to the loading direction at a frequency of 20 kHz. Initially, the oscillations cause the particles to densify through rearrangement. However, after a certain relative density (dependent on the size and shape of the powder particles) is reached, densification occurs through the deformation of the particles. Although heat input is not required, some heating occurs due to the high strain rate shear deformation of the powder. This heating may affect the structure of powders with non-equilibrium microstructures that are consolidated with UPC.

3. Ressearch Objective

Determine optimal set of process parameters by varying the amplitude, force, and compaction time. The optimal process parameters set will maximize the density of the compact while reducing the temperature rise due.

4. Procedure

5. Feedstock Powder Characterization



- Nominally pure atomized copper powder.
- 1,200 particles were counted and measured.
- A majority of the particles are between 1μm and 10 μm in size.

7. Process Characterization

- Peak temperatures between 250 °c and 600 °c were recorded.
- Increasing in amplitude would drastically increase the amount of heat generated during the weld.
- Extent of grain growth is proportional to increase in temperature.

a.

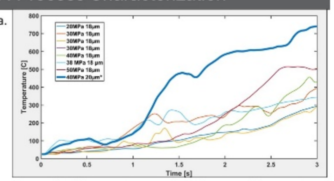


Figure 7a: Temperature vs. time for several parameter sets. Increasing pressure contributes to increase in heat due to a higher normal load on the powder. When the oscillation was increase, the temperature had also drastically increased.

b.

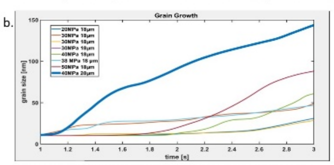


Figure 7b: Grain size vs. Time of parameter sets. An increase in temperature had resulted in an increase in grain size. A sample tested with 40 MPa and 20 μm had underwent grain growth of over 15 times its original size.

6. Densification Behavior

a.

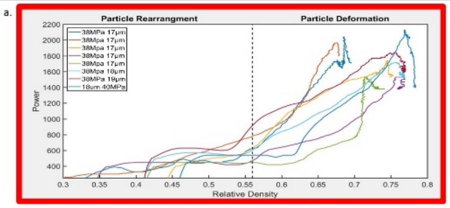


Figure 6a: The densification process occurs by particle rearrangement until the relative density equals ~0.6, after this threshold, particle deformation facilitates densification

b.

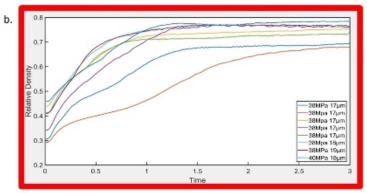


Figure 6b: Relative density vs. time for several process parameter sets. Both normal pressure and oscillation amplitude influence densification, but the oscillation amplitude has a more significant effect.

- Relative density of the powder plateaus at 80%
- The 20% porosity is due to uniform nanoporosity and microporosity due to non-uniform strain fields.

8. Conclusions

- The relative density and temperature of the compact can be estimated through the power that it observed after each welds.
- The ideal parameters for complete densification while minimizing heating are: 38 – 40 MPa; 3s; 17- 18 μm
- Increasing the amplitude, normal pressure, and compaction time all increase the amount of densification and temperature rise.
- This method for identifying optimal processing conditions can be applied to other material systems. In future work, we plan to extend this approach to nanostructured Cu-Ta, Cu-Ni-Sn, and nanostructured magnetic powders.

Acknowledgments

Ward, Austin et al. .Journal of Materials Processing Tech. 2018.
Thank you NSF foundation DMR 1460564 for sponsoring the REEMS REU program. Thank you PI, Mr. Sheinberg for organizing and finding such great professors for this internship. Thank you REEMS Mentor, Dr. Davis for being supportive through out the internship.

Raul Mora **Poster Number 7**

Predicting hardness of inorganic solids using machine learning

Raul Mora[1], Aria Mansouri Tehrani[2], Jakoah Brgoch[3]

[1]Department of Chemistry, *University of Houston*, Houston, 77204

[2]Houston Community College, REEMS REU Program, Houston, TX

Materials with high hardness are sought for numerous industries as tools and products with high durability. The hardness of a material is commonly determined using an indentation test, such as a Vickers hardness test, where a hardness greater than 40 GPa is considered superhard. In the search for new materials with exceptional mechanical properties, trial-and-error approaches require exploration whereas computation prediction could speed up this process. Machine learning is one approach that can be used to efficiently search for these materials. This approach employs algorithms to learn existing correlations in training datasets that can be expanded to explore unknown materials. Here, we show that machine learning models are capable of predicting the Vickers hardness of materials. Algorithms such as Support Vector Regression and Ridge Regression were used to train machine learning models based on obtained experimental data of different materials (310 compounds) extracted from the literate. A scoring method based on the coefficient of determination known as the R^2 score was used to determine that the validation accuracy for the Ridge and SVR regressions, which were 67.04% and 77.72%, respectively. A form of bias towards hard materials in the model was implemented by weighting the algorithms, particularly towards high hardness materials, because existing data on superhard materials is scarce. As a result, the scores for Ridge and SVR Regressions were 64.96% and 65.52%, respectively. The resulting models were used to make predictions on the hardness of other materials (98,094 compounds), which yielded an array of hardness that can be used as reference for future synthesis of materials.

This work was supported by the National Science Foundation (DMR 1460564)

Predicting Hardness of Inorganic Solids Using Machine Learning

R. Mora Contreras, A. Mansouri Tehrani, J. Brgoch

Department of Chemistry, University of Houston, Houston, TX 77204

HOUSTON COMMUNITY COLLEGE

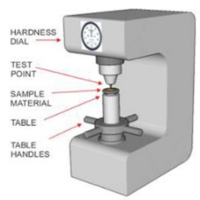
Introduction

Machine Learning is the process of extracting knowledge from data directly

Supervised learning can be used in material science and chemistry to predict a material's properties; in this case hardness

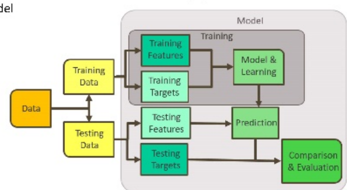
Hardness is defined as the resistance of the material to an indentation

Materials with Vickers hardness (H_v) > 40 GPa, are considered superhard



Predictive Modeling with respect to hardness

Here, a set of features based on elemental composition and targets based on experimental hardness values are employed to create the machine learning model



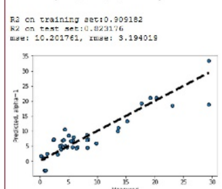
The Learning model was constructed in a jupyter notebook environment, with iPython language, using scikit-learn tools

Machine learning algorithms

Ridge Regression:

An implementation of a least squares regression that employs a regularization term α

$$\min \sum_1^{694}(y_i - w_i x_i)^2 + \alpha w_i^2$$

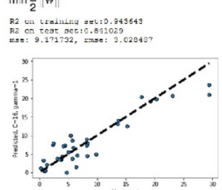


Support Vector Regression:

Creates a function that fits into the data to increase accuracy

Constant C controls the degree at which the function accommodates

$$\min \frac{1}{2}\|w\|^2$$

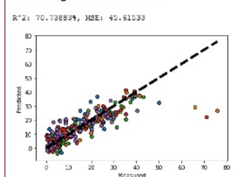


Cross Validation Methods

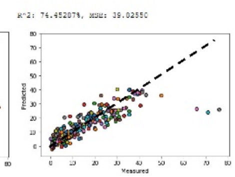
The 5-fold method was used to create a model which used 100% of the data (310 compounds) to create predictions

The Leave One Out method works in a similar way, but executes the process for every data point

The data needed to be randomized to prevent the model from basing its learning on sorted features



5-Fold CV SVR



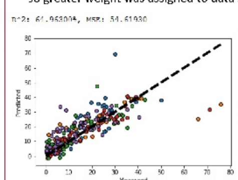
Leave One Out CV SVR

The models performed poorly on data points with high hardness values

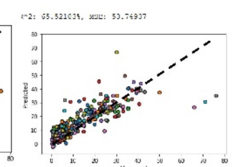
Attempts at dealing with high hardness data

Particular weight values were attributed to the dataset for the model to consider

More importance is given to data points with higher weight in the model, so greater weight was assigned to data sets with higher hardness values



Weighted 5-Fold CV SVR



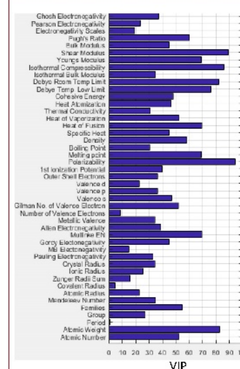
Weighted Leave One Out CV SVR

Performance of the models at high hardness value data sets improved slightly, at the cost of a lower prediction accuracy for the low hardness value datasets.

All weighted models suggested that Boron Carbide (B_4C) has a significantly higher hardness than what was measured

It was found that Boron Carbide is a hard material, commonly used in tank armor, hinting that the weighted model could successfully distinguish compounds with high hardness values

Feature Selection



Recursive Feature Elimination (RFE) ranks the features of the datasets based on how much they influence the performance of the model

RFE was used to determine from a statistical standpoint which properties give high hardness to a material

period, covalent radius, and number of valence electrons do not affect the predictions of the model,

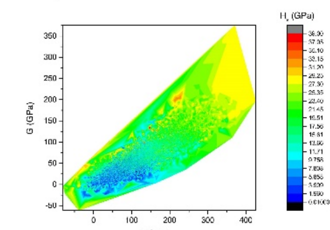
polarizability, isothermal compressibility, and bulk modulus were amongst the most relevant features

Knowing the correlation of these properties with hardness could aid in the search for superhard materials

Prediction and evaluation

Predictions were made on 98094 compounds from Pearson Crystal Database

The bulk modulus and shear modulus of a compound are expected to relate to material's hardness. Previous predictions of these properties are observed in relation to their predicted hardness values



As expected materials with high B and G tend to have higher hardness which could guide the future synthesis of hard materials.

References

1 – G. Akopov, M. T. Yeung, R. B. Kaner, Adv. Mater 2017, 29, 1604506.

2 – Chen, X-Q, Niu, H., Li, D., Li, Y., Intermetallics 2011, 19, 1275-1281.

3 – Abdusalyamova M.N., Shokirov H.S., Rakhmatov O.I., J. Less-Common Met., 1990, 166, 221-227

This work was supported by the National Science Foundation, the R. A. Welch Foundation and the State of Texas through the Texas Center for Superconductivity.

Quy Nguyen **Poster Number 8**

Peptide Functionalized Hyaluronic Acid for Treating Spinal Cord Injuries

Nguyen, Quy;[1,2] Lu,Xi;[1] Smith-Callahan, Laura;[1]

1. Vivian L Smith Department of Neurosurgery, Center for Stem Cell and Regenerative Medicine, McGovern Medical School, University of Texas Health Science Center at Houston, Houston. Texas
2. NSF REEMS REU program, Houston Community College, Houston, Texas

Corresponding Author: Smith Callahan, L A. Vivian L Smith Department of Neurosurgery, McGovern Medical School, University of Texas Health Science Center at Houston.
1825 Pressler Street. Institute of Molecular Medicine, Houston TX 77030
Email: Laura.a.smithcallahan@uth.tmc.edu

Spinal cord injury (SCI) can lead to paralysis, autonomic disorders, depression, or lower quality of life for patients. Unfortunately, there is no effective regenerative treatment for SCI. Stem cells can potentially replace neurons that are lost in SCI and help restore motor function. However, implanted cells cannot easily survive in the injury environment, which can contain many inflammatory molecules such as reactive oxygen species, without the protection of a scaffold. Hydrogels derived from Hyaluronic acid (HA) can potentially serve as a scaffold material because HA is an important component of the brain extracellular matrix (ECM) and can regulate cellular differentiation, migration, and angiogenesis. To optimize HA for delivering progenitor cells for treating SCI, we created and tested two different materials: 1) Di-functional HA (DifHA), which is a modified version of HA and can accept conjugation with peptides 2) PepHA, this is DifHA, with two different peptides based on ECM proteins, IKVAV and LREGGGC. Mouse neural progenitor cells were differentiated to become neurons on top of either material for five days. Cells were fixed and stained with fluorescent antibodies for MMP2, GAP43, and TUJ1. There was no detectable significant difference in the percentage of MMP2, GAP43, and TUJ1 positive cells for any of the surfaces. Quantification of the fluorescent intensity for MMP2 and GAP43 showed no significant difference either for any of the groups. However, PepHA showed significantly higher area of positive MMP2 staining compared to laminin. RT-PCR showed that PepHA trended towards higher expression of MAP2 and TUJ1 compared to DifHA and laminin. These results suggest that the signaling factors presented by PepHA may be stimulating greater neuronal maturation. For future work, we will investigate the ability of DifHA and PepHA to regulate the behavior of other neural cells such as astrocytes and oligodendrocyte.

This work is supported by the National Science Foundation (DMR 1460564), the Vivian L. Smith Department of Neurosurgery, William Stamps Farish fund and the Hermann Memorial Staman Ogilvie Research fund.

Peptide Functionalized Hyaluronic Acid Hydrogels for Treating Spinal Cord Injuries

Nguyen, Quy;[1,2] Lu,Xi;[1] Perera , T Hiran;[1] Smith-Callahan, Laura;[1]

1. Vivian L Smith Department of Neurosurgery, Center for Stem Cell and Regenerative Medicine, McGovern Medical School, University of Texas Health Science Center at Houston, Houston. Texas
2. REEMS program, Houston Community College, Houston, Texas

Introduction

Spinal cord injury (SCI) can lead to paralysis and lower patients' quality of life. Currently, there is no regenerative treatment for SCI. Stem and progenitor cells may be a potential SCI therapy by replacing cells such as neurons that are lost in SCI in the hope of restoring connectivity and motor function. Without a scaffold, most implanted cells do not survive in the injury environment. Hyaluronic acid (HA) may serve as a scaffold material[1] since 1) it is highly present within the brain extracellular matrix (ECM) and 2) has been shown to regulate cellular differentiation and migration. Further modifications to HA including peptide conjugation may increase cell attachment points and offer greater control over cell differentiation. We tested the effects of functionalizing HA with two ECM peptides, IKVAV (laminin 1) and LRE (Neuroligin) which have been shown to promote neurite outgrowth and motor neuron attachment[2,3]. We hypothesized that addition of these peptides to HA may promote neuronal maturation and survival of primary mouse neural progenitor cells.

Materials and Methods

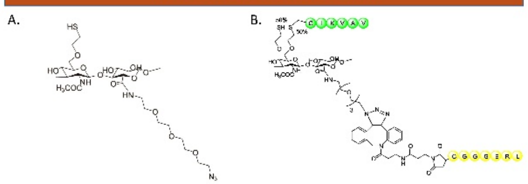


Figure 1: Chemical structures of A) Di-functionalized HA (DifHA, pre-peptide conjugation) and B) HA with peptides (PepHA, IKVAV and LREGGGC)

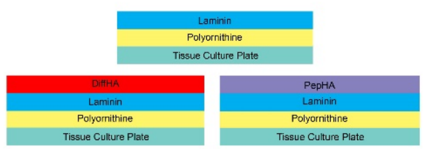


Figure 2: Plates were coated with poly-ornithine (10 mg/mL) overnight, laminin (10 μg/mL) for 2 h at 37°C, and finally DifHA or PepHA (1% solutions) for 1 h at 37°C

Cell culture

1. Mouse Neural Stem Cells (10,000 cells/cm^2) plated on top of material
2. 24h after plating, cells were differentiated for 5 days
3. Analyze using Immunohistochemistry (IHC) or RT-PCR

Maintenance Media

1. DMEM/F12 with Glutamax
2. FGF2/EGF (20 ng/mL each)
3. 1X N2/B27, 1% PENSTREP

Differentiation Media

1. DMEM/F-12 with Glutamax and Neural Basal media (1:1)
2. NT3/GDNF/BDNF (20 ng/mL each)
3. 1X N2/B27, 1% PENSTREP

Results

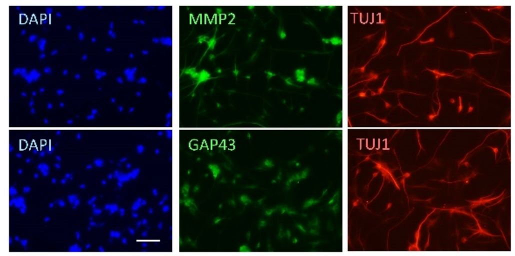


Figure 3: Representative images of cells stained for MMP2 (cell motility), TUJ1 (neuronal marker), GAP43 (plasticity marker), and DAPI (nucleus) cultured on DifHA. Cells looked similar for other surfaces. Pictures were taken using Nikon fluorescent microscope at 20x on day5. Majority of the cells expressed neuronal morphology and showed neurite extensions. Scale bar indicates 200 μm.

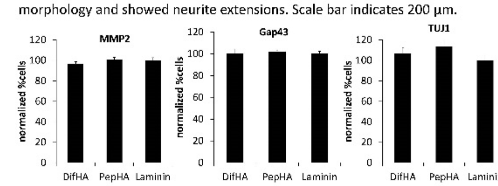


Figure 4: Quantification of the percentage of cells expressing MMP2, GAP43, and TUJ1 (normalized to laminin) on day 5. For all groups, 80-90% of the cells were positive for MMP2 or GAP43. There was no significant differences between any of the groups.

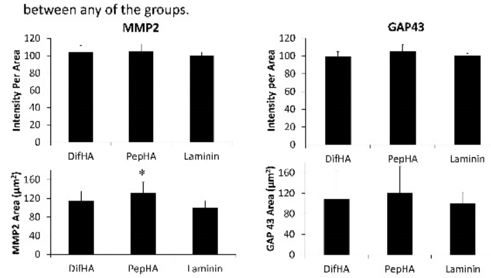


Figure 5: Normalized (to laminin) intensity per unit area of MMP2 and GAP43 staining were assessed as a semi quantitative indication of protein expression (Top Row). Normalized area with positive signal for MMP2 and GAP43 (Bottom Row). The total cell area positive for MMP2 for PepHA was significantly greater than that of laminin. There was no significant difference in cell density for all groups for MMP2. * indicates $p < 0.05$ compared to laminin.

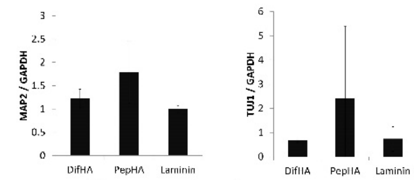


Figure 6: While not statistically significant, RT-PCR results showed a trend for greater relative expression of MAP2 (late neuronal marker) and TUJ1 for PepHA compared to DifHA at day 5.

Conclusions

Mouse neural progenitor cells successfully survived and differentiated to neurons on DifHA, PepHA and Laminin surfaces. While there were no significant differences in the fluorescent intensity of MMP2 and GAP43, PepHA lead to a larger area positive for MMP2. Gene expression results showed that PePHA trended towards greater expressions of MAP2 and TUJ1. These results suggest that the combination of LRE and IKVAV in HA could be stimulating greater neuronal differentiation. Future experiments could include analysis of gene expression from samples at an earlier differentiation point. As it is possible that PepHA could be driving faster differentiation. Other future work can also look at the impact of PepHA on other cells found within the nervous system such as astrocytes and oligodendrocytes as these cells play important roles in SCI such as the formation of the glial scar and myelinating axons.

Acknowledgement

The authors would like to acknowledge funding provided by the National Science Foundation (DMR 1460564), the Vivian L. Smith Department of Neurosurgery, William Stamps Farish fund and the Hermann Memorial Staman Ogilvie Research fund. Mouse Neural Stem cells were kindly provided by Dr. Qilin Cao's lab.

References

1. Seidlits SK, Khaing ZZ, Petersen RR, Nickels JD, Vanscoy JE, Shear JB, Schmidt CE: **The effects of hyaluronic acid hydrogels with tunable mechanical properties on neural progenitor cell differentiation.** *Biomaterials* 2010, **31**(14):3930-3940.
2. Lim HJ, Perera TH, Wilems TS, Ghosh S, Zheng Y-Y, Azhdarinia A, Cao Q, Smith Callahan LA: **Response to di-functionalized hyaluronic acid with orthogonal chemistry grafting at independent modification sites in rodent models of neural differentiation and spinal cord injury.** *Journal of Materials Chemistry B* 2016, 4(42):6865-6875.
3. Hunter DD, Porter BE, Bulock JW, Adams SP, Merlie JP, Sanes JR: **Primary sequence of a motor neuron-selective adhesive site in the synaptic basal lamina protein S-laminin.** *Cell* 1989, **59**(5):905-913.

Cristian Oviedo **Poster Number 9**

Environmentally Sustainable and Degradable Epoxy Resins

Cristian Oviedo,[1,2] Minjie Shen,[1] Dr. Megan Robertson[1]

1. Department of Chemical and Biomolecular Engineering, University of Houston, Houston, TX

2. REEMS REU Program, Houston Community College, Houston, TX

Corresponding Author: Robertson M.L., Department of Chemical and Biomolecular Engineering, University of Houston, 4726 Calhoun Road, S222 Engineering Building, Houston, TX 77004, Email: mlrobertson@uh.edu

Epoxy resins are used in a wide array of commercial markets from the transportation industry in automotive parts, to the energy sector in wind turbines, as well as in the home improvement sector in the form of adhesives and paint. The inability to degrade or recycle conventional petroleum-based epoxy resins after they have been used, combined with health and environmental sustainability concerns of petrochemical components used in these resins, have prompted interest in sustainable, biobased alternatives. Epoxy resins with comparable mechanical and thermal properties to that of conventional, petroleum-based materials, yet reduced environmental impact, are of much interest. Vanillic acid, derived from lignin feedstocks, and soybean oil were explored as sustainable precursors to epoxy resins. Epoxy resins were synthesized through the reaction of epoxidized biobased molecules with an anhydride curing agent. Their mechanical and thermal properties were subsequently characterized. The accelerated hydrolytic degradation behavior of the resins in acidic and basic solutions were demonstrated. It was discovered that vanillic acid-based resins offered comparable mechanical and thermal properties, and superior degradation behavior, to that of conventional petroleum-based resins. Potential mechanisms for the accelerated degradation behavior were probed, and more efficient methods of degrading the resins are proposed. The implications of this study are that vanillic acid-based epoxy resins are desirable alternatives to petroleum-based epoxy resins for use in commercial applications, as they offer similar functionality and superior degradability.

Funding for this research was provided by the National Science Foundation (DMR 1460564)

Environmentally Sustainable and Degradable Epoxy Resins

Cristian Oviedo, Minjie Shen, Megan L. Robertson

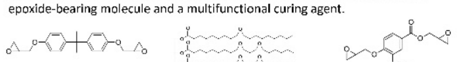
Department of Chemical and Biomolecular Engineering, University of Houston, 77004 TX

Introduction

- Environmentally sustainable and degradable epoxy resins have applications in automotive parts, wind turbines, and adhesives.
- The limited supply of petroleum, concern of environmental pollution, limitations on degradation and recycling of the material after usage, and health concerns of bisphenol A has prompted interest in an alternative bio-based epoxy resin to replace conventional petroleum based diglycidyl ether of bisphenol A (DGEBA) epoxy resins.
- Plant and algae derived chemicals such as vanillic acid and soybean oil, can be used to synthesize alternative epoxy resins with comparable properties to that of conventional DGEBA-based epoxy resins
- Our objective is to develop environmentally sustainable and degradable epoxy resins with comparable mechanical and thermal properties, and superior degradation behavior, to that of DGEBA-based epoxy resins.

Methods

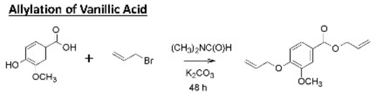
Epoxy resins were fabricated through the reaction between a multifunctional epoxide-bearing molecule and a multifunctional curing agent.



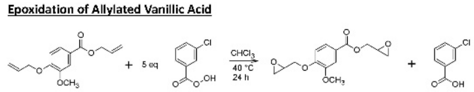
DGEBA — Epoxidized Soybean Oil (ESO) — Epoxidized Vanillic Acid(EVA)

EVA-based Epoxy Resin Synthesis

Allylation of Vanillic Acid



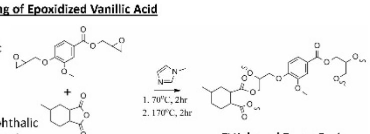
Epoxidation of Allylated Vanillic Acid



Anhydride Curing of Epoxidized Vanillic Acid

Epoxidized Vanillic Acid (EVA)

Methylhexahydrophthalic Anhydride(MHHPA)



EVA-based Epoxy Resin

Accelerated Hydrolytic Degradation

- Samples of ESO were placed in 3wt% NaOH and HCl solutions
- 0.04wt% NaN_3 was added to both solutions to prevent microbial growth
- Chemical degradation was monitored in increments of 8 hours, after which samples were neutralized, and then dried via vacuum oven.
- Masses were then recorded after samples were dried completely.

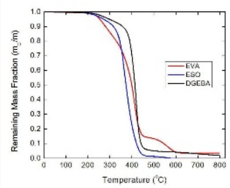
EVA-based Resin's Comparable Thermal Properties

Measurement of Glass Transition Temperature

Monomer Source	T_g(°C) MHHPA	T_g(°C) NMA
EVA	146 ± 3	103 ± 2
ESO	69 ± 2	65 ± 1
DGEBA	154 ± 3	99 ± 3

EVA-based epoxy resins has comparable glass transition temperature compared to traditional DGEBA based epoxy resins

Thermal Degradation Analysis

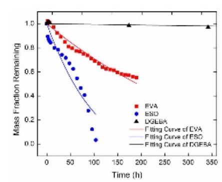


Monomer Source	$T_{5\%}$ (°C)
EVA	249 ± 5
ESO	271 ± 6
DGEBA	298 ± 3

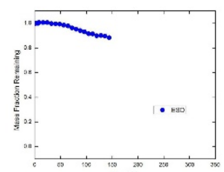
EVA and ESO-based epoxy resins showed desirable thermal degradation behavior

Accelerated Hydrolytic Degradation Behavior

3wt% NaOH



3wt% HCL



Retracting volume model:

$$\frac{m}{m_0} = (1 - k * t)^3$$

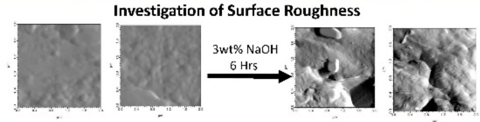
- m: mass remaining
- m_0: initial mass
- k: rate constant
- t: degradation time

Monomer Source	Rate Constant k (* 10^-3)
EVA	1.07 ± 0.1
ESO	3.58 ± 0.7
DGEBA	0.02 ± 0.01

- Retracting volume model used to model degradation behavior in 3wt% NaOH
- ESO-based resin showed rapid mass loss, due to its 3 ester groups that serve as cleavage points during hydrolysis
- EVA-based resin has one ester group, and thus shows less mass compared to ESO-based resin
- Hydrolysis in basic conditions showed surface erosion, while hydrolysis in acid conditions showed slight swelling of epoxy resin mass.

Investigation of Degradation Mechanisms

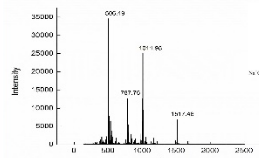
Investigation of Surface Roughness

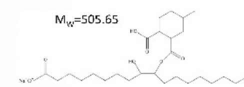


Average Surface Roughness: 5 nm — Average Surface Roughness: 50 nm

- Atomic force microscopy (AFM) showed that ESO-based resin appear to degrade, in a surface erosion manner, consistent with basic degradation conditions.
- Cleavage of the ester bonds in ESO based resins polymer structure could only occur on the surface of the solid, in what could be called a surface reaction zone site.

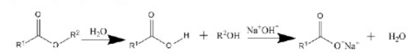
Identification of Possible Degradation Products





- An H^- is associated with the molecule and individual isotope peaks can decide z=1
- Cleavage of ester bonds is the mechanism of the hydrolysis reaction

A proposed hydrolysis degradation mechanism in basic conditions:



Conclusions

- Vanillic acid-based epoxy resins have comparable thermal properties as shown by both its comparable T_g and TGA curve, to that of DGEBA-based epoxy resin.
- The rapid degradation behavior can be explained by the cleavage of ester bonds in the polymer's repeat unit and this explains why ESO-based resin degrades faster than EVA-based resin, and why DGEBA-based resin has negligible degradation behavior.

Future work

- Conduct tensile testing for EVA-based epoxy resins to test the mechanical properties
- Verify the proposed mechanism by using changing basic solution for one sample, and not changing the basic solution in the other for both ESO and EVA-based epoxy
- Analyze bond strength in mass spectrum analysis of degradation products

References

[1] Yang et al., ACS Sus. Chem.Eng.2016,4,6524-6533
[2] Yang et al., Green Materials. 2012, 1, 125-134
[3] Kuang et al., RSC Adv., 2018, 8, 1493
[4] Busatto et al., Polymer Degradation and Stability, 2016, 125, 12-20

Acknowledgements

Thanks to Bart Sheinberg, the HCC REEMS REU program, and NSF DMR-1460564 and DMR-1611376 for this research opportunity and funding.

Celsa Pachlhofer **Poster Number 10**

Nucleation and Growth of Mossy Zinc Electrodeposits from Alkaline Zincate Solutions

Celsa Pachlhofer[1], Fan Wang[2], Ming Tang[2]

[1]REEMS REU Program, The West Houston Center for Science & Engineering, Houston Community College, Houston, TX

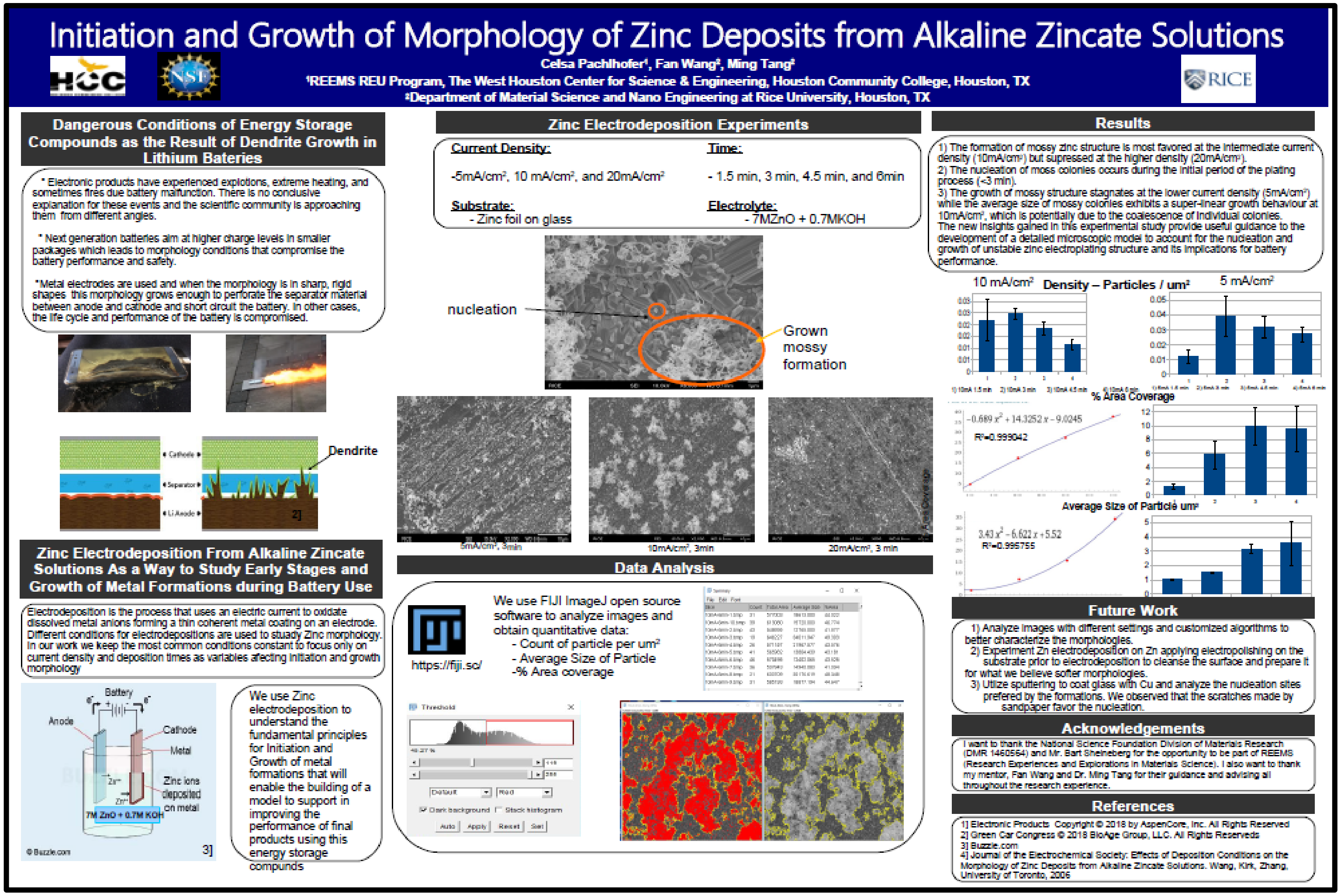
[2]Department of Material Science and Nano Engineering at Rice University, Houston, TX
email: celsacanedot@gmail.com

Zinc metal is a promising electrode material for the next-generation high-energy storage systems. The morphological change of the Zinc electrode during charge/discharge is an important factor in the stability and performance of zinc-based batteries. In particular, the formation of mossy zinc structure, which consist of entangled nanosized filaments, on zinc surface during electrodeposition poses a significant challenge because it causes irreversible reduction in battery capacity and could even short-circuit the batteries. Understanding the early behaviour and conditions of mossy zinc growth is important for the control and supression of undesirable zinc plating morphologies.

In this study, we investigate the nucleation and growth kinetics of mossy zinc structure through systematic electroplating experiments. Zinc is plated onto zinc substrate under a range of current densities (5, 10, 20 mA/cm^2) and deposition times (1.5, 3, 4.5, 6 min) in zincate solution (7M ZnO + 0.7M KOH). We focus on the early stage of the electrodeposition process so that the nucleation and growth rates of individual zinc mosses can be measured. The surface morphology of the deposited samples are imaged by scanning electron microscope (SEM). The SEM images are subsequently analyzed by image analysis algorithms in FIJI ImageJ software to measure the areal density, size distribution and total coverage of zinc moss colonies. The obtained results lead to the following conclusions: 1) The formation of mossy zinc structured is most favored at the intermediate current density (10mA/cm^2) but supressed at the higher density of 20mA/cm^2; 2) The nucleation of moss colonies occurs during the initial period of the plating process (<3min); 3) The growth of mossy structure stagnates at the lower currrent density of 5mA/cm^2 while the average size of mossy colonies exhibits a super-linear growth behaviour at 10mA/cm^2, which is potentially due to the coalescence of individual colonies. The new insights gained in this experimental study provide useful

guidance to the development of a detailed microscopic model to account for the nucleation and growth of unstable zinc electroplating structure and its implication for battery performance.

This work is supported by the National Science Foundation (DMR- 1460564) and the Houston Community College District, and Rice University.



Initiation and Growth of Morphology of Zinc Deposits from Alkaline Zincate Solutions
Celsa Pachlhofer[1], Fan Wang[2], Ming Tang[2]
[1]REEMS REU Program, The West Houston Center for Science & Engineering, Houston Community College, Houston, TX
[2]Department of Material Science and Nano Engineering at Rice University, Houston, TX
HCC
NSF
RICE
Dangerous Conditions of Energy Storage Compounds as the Result of Dendrite Growth in Lithium Bateries
* Electronic products have experienced explotions, extreme heating, and sometimes fires due battery malfunction. There is no conclusive explanation for these events and the scientific community is approaching them from different angles.
* Next generation batteries aim at higher charge levels in smaller packages which leads to morphology conditions that compromise the battery performance and safety.
*Metal electrodes are used and when the morphology is in sharp, rigid shapes this morphology grows enough to perforate the separator material between anode and cathode and short circuit the battery. In other cases, the life cycle and performance of the battery is compromised.
Cathode
Separator
Li Anode
Dendrite
2]
Zinc Electrodeposition From Alkaline Zincate Solutions As a Way to Study Early Stages and Growth of Metal Formations during Battery Use
Electrodeposition is the process that uses an electric current to oxidate dissolved metal anions forming a thin coherent metal coating on an electrode. Different conditions for electrodepositions are used to stuady Zinc morphology. In our work we keep the most common conditions constant to focus only on current density and deposition times as variables afecting initiation and growth morphology
Battery
Anode
Cathode
Metal
Zinc ions deposited on metal
7M ZnO + 0.7M KOH
© Buzzle.com
3]
We use Zinc electrodeposition to understand the fundamental principles for Initiation and Growth of metal formations that will enable the building of a model to support in improving the performance of final products using this energy storage compunds
Zinc Electrodeposition Experiments
Current Density:
-5mA/cm², 10 mA/cm², and 20mA/cm²
Time:
- 1.5 min, 3 min, 4.5 min, and 6min
Substrate:
- Zinc foil on glass
Electrolyte:
- 7MZnO + 0.7MKOH
nucleation
Grown mossy formation
5mA/cm², 3min
10mA/cm², 3min
20mA/cm², 3 min
Data Analysis
We use FIJI ImageJ open source software to analyze images and obtain quantitative data:
- Count of particle per um²
- Average Size of Particle
-% Area coverage
https://fiji.sc/
Threshold
Default
Red
Dark background
Stack histogram
Auto
Apply
Reset
Set
Results
1) The formation of mossy zinc structure is most favored at the intermediate current density (10mA/cm²) but supressed at the higher density (20mA/cm²).
2) The nucleation of moss colonies occurs during the initial period of the plating process (<3 min).
3) The growth of mossy structure stagnates at the lower current density (5mA/cm²) while the average size of mossy colonies exhibits a super-linear growth behaviour at 10mA/cm², which is potentially due to the coalescence of individual colonies.
The new insights gained in this experimental study provide useful guidance to the development of a detailed microscopic model to account for the nucleation and growth of unstable zinc electroplating structure and its implications for battery performance.
10 mA/cm²
Density – Particles / um²
5 mA/cm²
% Area Coverage
$-0.689x^2 + 14.3252x - 9.0245$
R²=0.999042
Average Size of Particle um²
$3.43x^2 - 6.622x + 5.52$
R²=0.995755
Future Work
1) Analyze images with different settings and customized algorithms to better characterize the morphologies.
2) Experiment Zn electrodeposition on Zn applying electropolishing on the substrate prior to electrodeposition to cleanse the surface and prepare it for what we believe softer morphologies.
3) Utilize sputtering to coat glass with Cu and analyze the nucleation sites prefered by the formations. We observed that the scratches made by sandpaper favor the nucleation.
Acknowledgements
I want to thank the National Science Foundation Division of Materials Research (DMR 1460564) and Mr. Bart Sheineberg for the opportunity to be part of REEMS (Research Experiences and Explorations in Materials Science). I also want to thank my mentor, Fan Wang and Dr. Ming Tang for their guidance and advising all throughout the research experience.
References
1] Electronic Products Copyright © 2018 by AspenCore, Inc. All Rights Reserved
2] Green Car Congress © 2018 BioAge Group, LLC. All Rights Reserveds
3] Buzzle.com
4] Journal of the Electrochemical Society: Effects of Deposition Conditions on the Morphology of Zinc Deposits from Alkaline Zincate Solutions. Wang, Kirk, Zhang, University of Toronto, 2006

Tanvi Parikh **Poster Number 11**

SYNTHESIS AND CHARCTERIZATION OF SUPERCONDUCTING YBCO

Tanvi Parikh[1,2], Dr. James Meen[1], Dr. Karoline Mueller[1]

[1] Texas Center for Superconductivity, University of Houston, Houston, TX 77204
[2] REEMS Program, Houston Community College, Houston, TX 77082

Corresponding author: James K Meen, Texas Center for Superconductivity, University of Houston 3369 Cullen Blvd Rm 202, Houston, TX 77024 Email: jmeen@uh.edu

The high-temperature yttrium barium copper oxide superconductor with nominal composition $YBa_2Cu_3O_{7-\delta}$ (YBCO) actually has a range in cation contents. Nominal YBCO crystallizes from a liquid in equilibrium with Y_2BaCuO_5 (Y211) while Cu-rich YBCO (Cu=3.25) forms in equilibrium with CuO and not with Y211[1]. Several studies suggest there could be variability in properties of YBCO with different cation ratios but thus far no systematic study of properties of YBCO with Cu content has been performed. Supercurrent in YBCO is carried by Cu-O atomic layers. Increasing the copper content over nominal by 8% results in more Cu-O layers and potentially increases J_c (current carrying capacity) and, possibly, T_c (superconducting transition temperature) and permits growth of superconductors of higher performance. As superconductors are used in fields from medical to aeronautical, an increase in performance is greatly desired. Higher J_c results in greater efficiency of the frictionless motors, power storage devices, trains and magnetic devices. Power cables will be able to carry greater currents with no loss of electricity.

Synthesis of pure YBCO with a controlled composition is a challenge. As YBCO melts incongruently to Y211 and liquid, all melt-generated YBCO contains Y211, which causes modification in the properties from those of pure YBCO. It also means that crystallized YBCO has a composition different from that of the bulk prepared. In order to achieve the goal, we performed experiments to get rid of the Y211 by melting and crystallizing YBCO at a range of different temperatures and determining the phases generated. A sample of Cu-rich YBCO was prepared and sintered at different temperatures in a tube furnace and treated with various techniques in the thermocouple system, in order to achieve homogeneity in the system of samples. The homogeneity and the characteristics of the sample were observed by Scanning Electron Microscope. The sample was also studied by X-ray diffractometer to find the structure of crystals. Further, differential thermal analysis results were obtained when the sample was put in a STA furnace. Y211 is replaced by Y_2O_3 at about 1300 °C; the liquid temperature is near 1500 °C. Most sample crucibles employed at these temperatures react with YBCO melts so the superconductor generated is poisoned. Next task is to prepare $BaZrO_3$-coated crucibles (m.p.≈2600 °C) that are unreactive with YBCO and generate homogeneous liquids (T>1500 °C) that will crystallize directly to Cu-rich YBCO for property measurements.

This work is supported by National Science Foundation Division of Materials Research REEMS (NSF DMR 1460564)

[1] Chun Ming Hou, and James K. Meen. "Range in Cation Ratio of $YBa_2Cu_3O_{7-\delta}$ Crystallized from Liquids." *IEEE Transactions on Applied Superconductivity*, vol. 25, no. 3, June 2015

SYNTHESIS AND CHARACTERIZATION OF SUPERCONDUCTING YBCO

Tanvi Parikh[1,2], Dr James Meen[1], Karoline Mueller[1]
[1] Texas Center for Superconductivity, University of Houston; [2] REEMS Program, Houston Community College

STORY OF YBCO

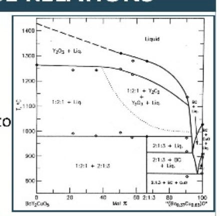
- Yttrium barium copper oxide (YBCO) is a high temperature superconductor with nominal composition $YBa_2Cu_3O_{7-\delta}$
- Several studies suggest there could be variability in properties of Cu-rich YBCO (Cu=3.25) but so far no systematic study of properties of YBCO with Cu content has been performed
- Copper Oxide layers carry supercurrent in YBCO and increasing the copper content over nominal by 8% results in more Cu-O layers and potentially increases J_c and T_c
- Superconductors are used in all the fields from medical to aeronautical. The efficiency of the motors, power storages, trains , magnets will increase as they will be frictionless and no loss of electricity will be observed

MAKING OF YBCO

1. Stoichiometry calculations to make 1 gram of YBCO (ideal ratio is 1:2:3)
2. Grind the starting materials together using a mortar and pestle with sub micron roughness
3. Press it into a pellet using the hydraulic press
4. Place the pellet in the furnace at 700 °C to calcine the sample and evolve CO_2
5. Repeat the same procedure at 800 °C and 900 °C to complete the reaction

TERNARY PHASE RELATIONS

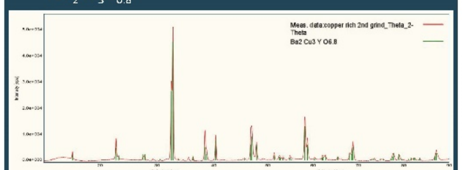
- Phase relations are used to understand the melting temperatures of Y_2O_3 ,BaO and CuO
- YBCO melts at near 1000 °C to Y211 and liquid
- Y211 is replaced by Y_2O_3 at about 1300 °C; the liquidus temperature is near 1500 °C.



ANALYSIS OF THE STRUCTURE AND HOMOGENEITY OF YBCO

X-Ray Diffractometer (XRD)

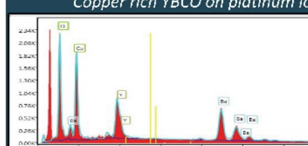
- Showed the structure of crystals by studying the positions of peaks
- Obtained results are compared to reference data
- Copper Rich YBCO was matched to the formula $YBa_2Cu_3O_{6.8}$



Scanning Electron Microscope (SEM)

- Checked the homogeneity and characteristics of the sample
- Compare the obtained ratios with the ideal ratios and check for the presence of Y211

Copper rich YBCO on platinum loop in SEM

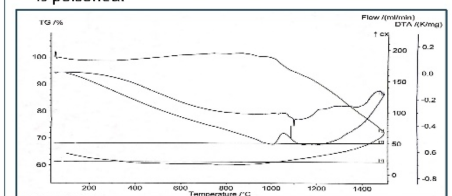


Element	Atomic %
O K	54.1
Y L	8.62
Ba L	15.46
Cu K	21.82

SEM analysis and ratios of copper rich YBCO

SIMULTANEOUS THERMAL ANALYSIS

- Differential thermal analysis (DTA) results were obtained when the sample was put in a STA furnace up to 1500 °C
- Most sample crucibles employed at these temperatures react with YBCO melts so the superconductor generated is poisoned.



Reaction of graphite crucible with Oxygen released from YBCO under the atmosphere of Helium gas

POTENTIAL DIRECTIONS

- Prepare $BaZrO_3$-coated crucibles that are unreactive with YBCO
- Generate homogeneous liquids that will crystallize directly to Cu-rich YBCO for property measurements.

ACKNOWLEDGEMENTS

- This work is supported by NSF DMR 1460564 of Materials Research REEMS and thanks to the principle investigator Bart Sheinberg.
- I would like to acknowledge the efforts of Dr. James Meen and Dr. Karoline Mueller
- Special thanks to Dr. Davis for her help and encouragement

REFERENCES

- Chun Ming Hou, and James K. Meen. "Range in Cation Ratio of $YBa_2Cu_3O_{7-\delta}$ Crystallized From Liquids." *IEEE Transactions on Applied Superconductivity*, vol. 25, no. 3, June 2015

Lucas Teague **Poster Number 12**

Microprobe Scans on Different Oxygen Phases

Teague, L.[1]; Meen, J.[2]; Müller, K.[2]

[1]REEMS Program, West Houston Center for Science & Engineering, Houston Community College, Houston, TX 77082.

[2]Texas Center for Superconductivity, University of Houston, Houston, TX 77204.

The Kα x-ray, generated from an oxygen atom after ionization, is due to an electronic transition from the 2p to the 1s energy level. In oxides (MgO, Al_2O_3, Fe_2O_3, etc.) the 2p electrons are involved in the bonding of oxygen to a metal. This means that the energy of the "2p" electrons is different in different oxides and thus the energy of the O Kα x-ray differs between different oxides. Different oxygen-bearing phases have O x-ray peaks that differ from each other in both peak position and breadth:height. Oxygen analysis by x-ray emission spectrometry compares the maximum height of the x-ray peak of a standard and an unknown. Differences in the peak characteristics between different oxides, therefore, result in systematic errors. To counter this, the shape of the peak has been mapped on a JEOL JXA-8600 Electron Microprobe but a full scan takes 12 or more hours. Not only is this machine-intensive, machine drift means that the peak shape has poor reproducibility. The goal of the research was to change the settings, so that the peak shape would be reproducible with better than 1% scatter and take less time. Decreasing the counting time at each energy increment and increasing the size of the increment spacing would decrease the time required for each scan. Using the scan data, I created graphs which have electron counts per second per nA vs. spectrometer position in mm. A graphing program fitted a Voigt curve to each data-set. The peak analyzer on the program computed the maximum position and intensity on the Voigt curve. Replicate scans were made and compared for peak position and intensity, also point by point comparison. I found that 4 hours is a good time to obtain a peak with better than 1% scatter.

Funding for this research was provided by the National Science Foundation (DMR 1460564)

Microprobe Scans of Oxides

Teague, L.[1]; Meen, J.[2]; Müller, K.[2]
[1]REEMS Program, West Houston Center for Science & Engineering, Houston Community College, Houston, TX 77082.
[2]Texas Center for Superconductivity, University of Houston, Houston, TX 77204.

Intro

- $Y_1Ba_2Cu_3O_{7-\Delta}$ is a superconductor.
- YBCO can have different O contents, which can change its performance.
- The Electron Microprobe is a good tool to determine chemical compositions at the micron scale.
- Oxygen absolute values have not been determined for YBCO by microprobe.

Oxides

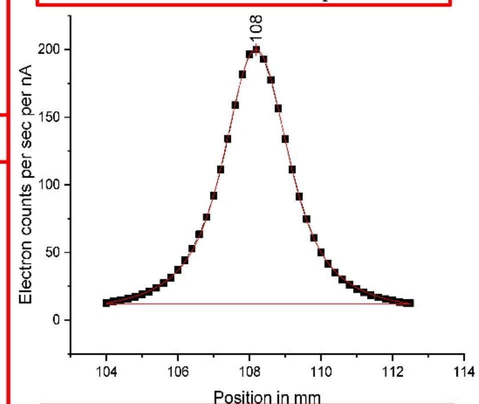
- $K\alpha$ x-rays are generated after ionization by 2p to 1s electron transitions.
- In an oxide the oxygen's 2p electrons bond differently from metal to metal.
- Different oxides have varying energies.
- Thus, O x-ray peaks differ in position and height:breadth.
- Comparing different peaks from different oxides results in systematic error.

Scans on Oxides

1. A scan counts the $K\alpha$ x-ray emission.
2. The graph had electron counts per sec per nA vs position in mm.
3. Standard Deviation was taken point by point; largest STD was divided by intensity to get % error.
4. This was repeated with different step sizes until 1% precision was achieved.

Curve Fitting Voigt

- Origin lab was used to fit Voigt curves to the data.
- Voigt curve is a convolution of Gaussian and Lorentzian equations.



Example

Position (mm)	Height	Height	STD
108.0	198.1	197.1	0.72
108.2	202.7	200.9	1.15
108.4	195.8	193.8	1.31

(1.31/202.7)*100% = 0.646%
1.31 is the largest STD. 202.7 is the largest height. 0.646% is the percent error.

Comparing Different Scans

- Scans with the same settings at different points on the oxide were compared to see if the step size is reproducible to 1% error.
- 10 scans at different points on the oxide is generally enough for comparing.

Results

- The original scan time was more than twelve hours.
- Now, it is less than 4 hours.
- This means that you can take less time for each scan without losing precision.

Future Work

- Compare MgO, Al_2O_3, Fe_2O_3, etc. Oxygen peaks.
- Use the technique to make microprobe scanning faster.

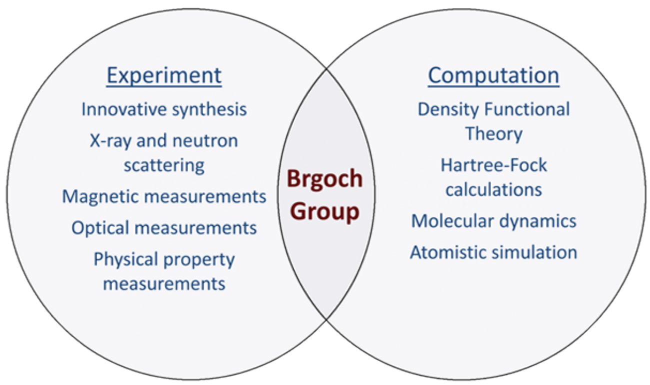
Acknowledgements

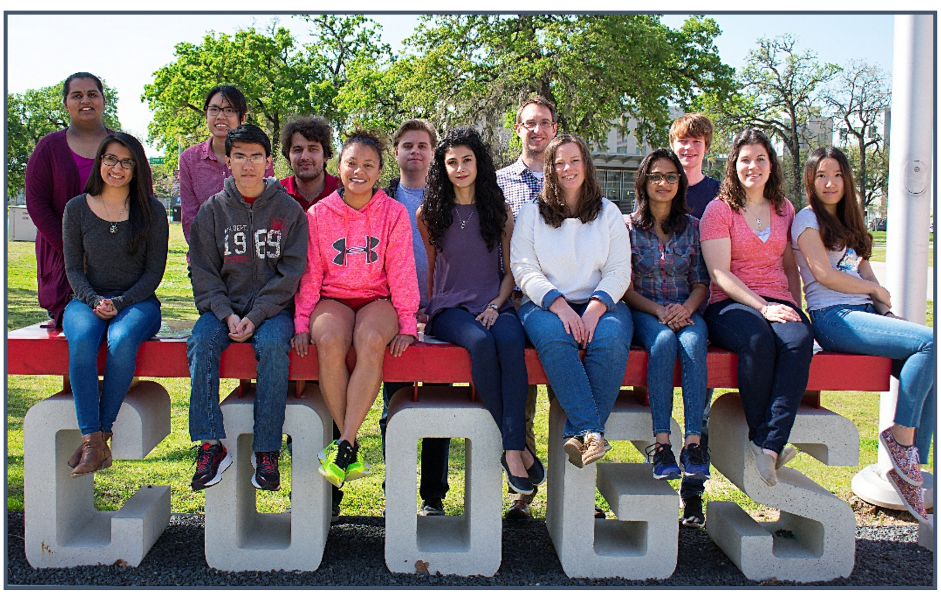
- Principal Investigator Sheinberg
- REEMS REU
- NSF DMR 1460564
- HCC
- UH Texas Center for Superconductivity

2018 REEMS Research Professors

Dr. Jakoah Brgoch, Department of Chemistry, University of Houston
http://jbrgoch.chem.uh.edu/
REEMS REU Students: Edward Armijo and Raul Mora

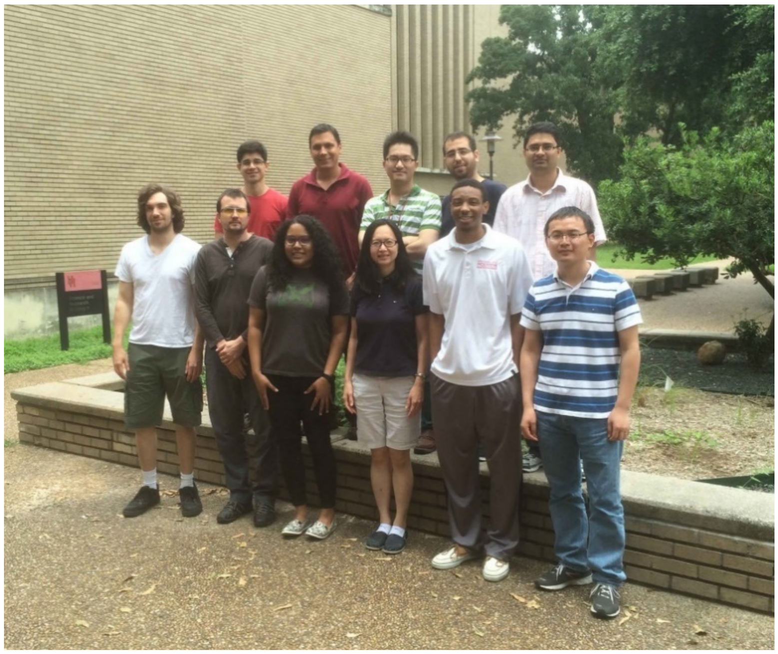
Students in the Brgoch group are experts in inorganic synthetic chemistry, numerous characterization techniques, and computational chemistry methods. Connecting these research approaches allows the group to solve current problems in a multitude of complex functional inorganic materials.





Front (L-R): Shruti Hariyani, Phu-Cuong Phan, Angelica Cobb, Sogol Lotfi, Erin Finley, Adhessha Danthanarayana, Anna Duke, Ya Zhuo *Back (L-R)*: Gayatri Viswanathan, Amber Lim, Aria Mansouri, Anton Oliynyk, Jakoah Brgoch, Sean Bailey

Dr. Margaret S. Cheung-Wyker, Department of Physics, University of Houston and Center for Theoretical Biological Physics, Rice University
https://mynsm.uh.edu/wiki/projects/cheunggroup
REEMS REU Student: Michael Dean



(Left to right). Front row: Jake, Oleg, Lenaya, Dr. Cheung, Rodney, Pengzhi.
Back row: Andrei, Fabio, Victor, Ezzat, Swarnendu.

Theoretical Biological Physics, Soft Condensed Matter, and Clean Energy

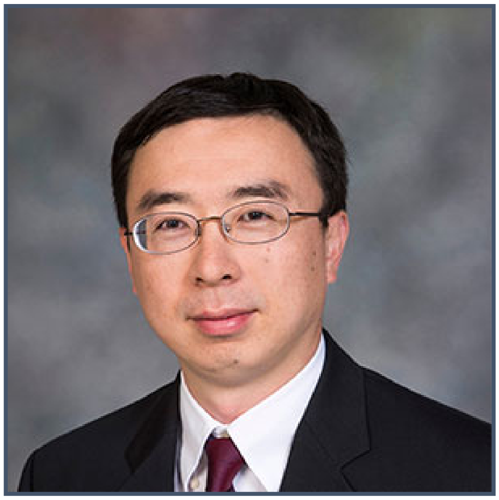
One of the goals of the Cheung group is to discover interesting macromolecular dynamics under cell-like conditions by applying molecular simulation methods. Cellular milieu is a crowded and concentrated environment that impacts the behavior of macromolecules. It can affect the rate of protein folding, protein association, and even the overall conformational changes that cannot be probed in dilute solutions. Examples of the simulation tools used in our investigations include coarse-grained molecular simulation, all-atomistic molecular simulation, and bioinformatic data-mining to investigate the structural behavior and statistical properties of large biomolecules in cellular milieu. To tackle macromolecular dynamics across multiple orders of magnitude in both space and time, we develop a state-of-the-art multi-scale molecular simulation and the utilization of high-performance computing resources to simulate very large systems efficiently.

Dr. Zachary Cordero, Department of Materials Science and NanoEnginering, Rice University
https://msne.rice.edu/Content.aspx?id=2147484079
REEMS REU Students: Angel Chagolla and Jackson Mang

Zachary Cordero
Assistant Professor

Dr. Cordero leads the Additive Lab in the Department of Materials Science and NanoEngineering at Rice University. The Additive Lab has two complementary research thrusts. The first thrust is to develop metal additive manufacturing techniques for printing parts with complex shapes and precisely-controlled microstructures. The second leverages these techniques to probe structure-property relationships in metals.

Dr. Ming Tang, Department of Materials Science and NanoEnginering, Rice University
https://msne.rice.edu/content/ming-tang
REEMS REU Students: Leen Almaasarani and Celsa Pachlhofer



Ming Tang, Assistant Professor of Materials Science and NanoEngineering

Dr. Tang's group is interested in materials phenomena at mesoscale, which bridge between atomistic building blocks and macroscopic properties. The focus of his research is two-fold: 1) advance novel mesoscale modeling techniques such as the phase-field method to enable more faithful and efficient simulation of structural or functional materials over ever increasing length and time scales, and 2) combine simulation (relying heavily on parallel computation), theory and experiment to explain and predict the thermodynamic stability and kinetic evolution of mesoscale-level structures under different stimuli (thermal, electrochemical, radiational, etc.), and apply obtained insights to tailor microstructural features for improved performance. Current research topics include electrochemically driven phase transformations in energy storage materials such as lithium-ion batteries, grain boundary complexion transitions, microstructural evolution in extreme environment and self-assembly kinetics in soft matter systems.

Dr. James K. Meen, Department of Chemistry and The Texas Center for Superconductivity, University of Houston and Department of Chemistry
http://www.uh.edu/research/mcf/
REEMS REU Students: Lucas Teague and Tanvi Parikh

Materials Characterization Facility of the University of Houston

The Materials Characterization Facility (MCF) is housed in the Houston's Science Center (HSC) building of the University of Houston's Main Campus. We are part of the Texas Center for Superconductivity of the University of Houston (TcSUH). We specialize in **micro-chemical/structural characterization of solid state materials by x-ray and electron beam techniques**.

Areas of active research include:

- **Conduct Phase Equilibria Studies on Systems Related to High Temperature Superconductors (HTS) Materials.**
- **Development of High Temperature and High Pressure Experiments for Synthesizing Materials.**
- **Development of the Analytical Capabilities of Electron Beam Instruments.**
- **Conduct Studies in Petrology and Geochemistry (mainly igneous systems)**

Dr. Megan Robertson, Department of Chemical and Biomolecular Engineering, University of Houston
http://robertsongroup.chee.uh.edu/
REEMS REU Student: Cristian Oviedo

Polymeric Materials
Tailored Structure, Properties, and Function

The objective of our research group is to develop polymeric materials with enhanced physical properties and function. We specialize in polymer synthetic techniques, structural characterization (small-angle neutron, x-ray and light scattering), thermodynamics and self-assembly, and development of structure-property relationships.

Research projects are focused on the following areas:

Sustainable and biodegradable polymers derived from renewable resources

Advanced materials for wind energy

Structure and dynamics of block copolymer micelles

pH-responsive, antifouling polymer brushes

Multicomponent and multiphase polymer blends

Dr. Laura Smith Callahan, PH.D., Neurosurgery & Center for Stem Cell and Regenerative Medicine, Department of Neurosurgery, McGovern Medical School, University of Texas Health Science Center at Houston.

https://med.uth.edu/neurosurgery/smith-callahan-lab/

REEMS REU Student: Quy Nguyen

The Smith Callahan Laboratory focuses on the developing tissue engineering approaches toward clinical treatments for spinal cord injury, traumatic brain injury and cartilage defects using an interdisciplinary approach involving techniques from cell, molecular, and stem cell biology, chemistry, and material science. Utilizing engineering approaches, the laboratory seeks to optimize scaffold design and the expansion of clinically relevant cell sources.

CURRENT PROJECTS

1) Development of multi-component scaffolds to facilitate tissue regeneration through better replication of the native extracellular matrix.
2) Optimization of culture surfaces for the differentiation of human induced pluripotent stem cells to neural stem cells and oligodendrocyte progenitor cells.
3) Identification of optimal artificial matrix properties such as bioactive signaling moiety concentration or mechanical properties using combinatorial approaches.
4) Synthesis of novel biomaterials for spinal cord, brain, and vertebral disk repair.

Dr. Rafael Verduzco, Department of Chemical and Biomolecular Engineering, Rice University

http://verduzcolab.blogs.rice.edu/

REEMS REU Students: Chiamaka Agu and Mary Pinedo

The Verduzco laboratory focuses on the development of complex polymeric materials. We take advantage of advanced polymer synthesis techniques and nanoscale characterization tools to design and characterize polymers at multiple length scales. Current areas of interest include all-conjugated block copolymers for photovoltaics, bottlebrush polymers as responsive surface coatings, liquid crystal elastomers for biomedical applications, and polymers for enhanced oil recovery. The unifying theme of this work is engineering materials at the molecular level to achieve a stronger fundamental understanding of material properties.

2018 REEMS REU JUDGES

DR. FORREST J. "JACK" AGEE
Retired September 01, 2006

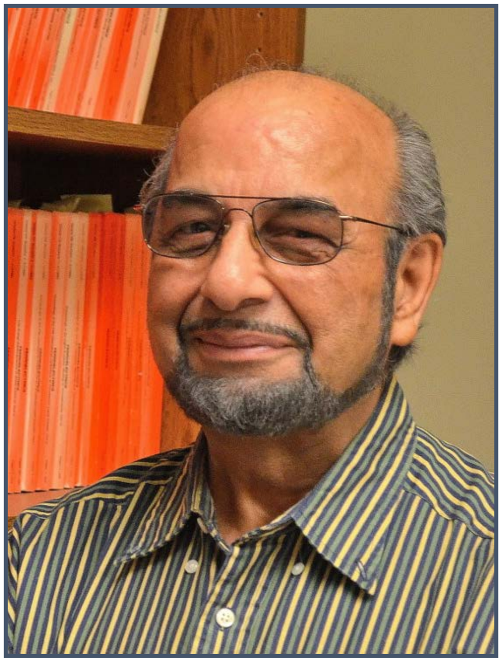
Dr. Forrest J. "Jack" Agee, a member of the Senior Executive Service, is Director of Physics and Electronics, Air Force Office of Scientific Research, Arlington, Va. He is responsible for the $80 million Air Force basic research program in physics and electronics, assuring the excellence and relevance of a broad research portfolio. His program encompasses hundreds of university grants and supports work of undergraduates and more than 300 graduate students. This work also supports basic research within the Air Force Research Laboratory, industry and overseas. The research includes novel space-craft engineering, semiconductor device research,nano-technology, electronic sensors, polarimetry research, gravitometry, lasers, plasmas, high-power radio frequency sources, high-temperature superconductivity engineering, atomic and nuclear physics, space optics, and imaging and opto-electronics. Agee plans, coordinates and executes a research program conducted by scientists in academia, industry and Air Force laboratories. He was appointed to the SES in 1998.

Prior to beginning his career with the Air Force, Dr. Agee worked as a U.S. Navy physicist in acoustics related to silencing submarines. He also worked in low-temperature physics for the U.S. Army at Fort Belvoir, VA. In the 1970s, he joined the Harry Diamond Laboratory in Adelphi, MD. He handled many assignments of increasing scope and responsibility, initially in nuclear electromagnetic pulse hardening and testing for the Safeguard Anti-Ballistic Missile System and for Army tactical systems. As the Technical Director, he led a major, strategic, Defense Nuclear Agency Electromagnetic Pulse Test for the Commander in Chief of Pacific Forces. For three years he managed strategic command, control and communications programs at The BDM Corp., including the Airborne Command Post. In 1982 Dr. Agee became Director of the Aurora Radiation Test Facility that tested the Peacekeeper missile and other systems at the Harry Diamond Laboratory. In the Army's high-power microwaves program, Dr. Agee led research and development efforts in sources, and in 1990, became Director of the Army program. His efforts led to developing the AN/VLQ-9 and AN/VLQ-10 Shortstop electronic warfare systems during operations Desert Shield and Desert Storm. The Shortstop System protected U.S. forces in Bosnia and now has seven versions, including two that are deployed in Iraq in a counter-IED role. Dr. Agee formed the Joint Directors of Laboratories Panel on Directed-Energy Weapons in 1990, and chaired the panel until 1993. That same year, he began his Air Force career in the Directed-Energy Program at Phillips Laboratory at Kirtland Air Force Base, NM where he led the research program in high-power microwave sources.

Dr. Agee's principal fields of interest are in electrical engineering, pulsed power, microwave generation, electromagnetics and superconductivity. In physics, his interests include nuclear physics, plasma physics, semiconductor physics and lasers. He has written or co-written more than 200 publications and inventions in these areas.

EDUCATION
1963 Bachelor of Science in physics, high honors, Clemson University, Clemson, S.C.
1965 Master of Science degree in physics, University of Virginia, Charlottesville
1967 Doctor of Philosophy degree in physics, University of Virginia, Charlottesville

Dr. Amar Bhalla
Distinguished Research Professor of Electrical and Computer Engineering
University of Texas San Antonio



Amar Bhalla is a Distinguished Research Professor of Electrical and Computer Engineering at University of Texas at San Antonio (San Antonio, TX) since 2007. His professional career also includes more than thirty years of research, teaching, and service as Professor (Electrical Engineering) and Senior Scientist (Materials Research Institute) at The Pennsylvania State University (University Park, PA) from 1975 to 2007. He served as a National Science Foundation Program Director in the Division of Materials Research (1993-96) and held over 15 distinguished visiting professor/scientist assignments around the globe. He also participated with the team conducting 'Materials Processing in space under zero-gravity environment' at NASA's Marshall Space Flight Center as a National Research Council Research Fellow, National Academy of Science.

Bhalla's contribution on various aspects of basic and applied electronic ceramic materials research is detailed in his more than 700 journal publications, especially in pyroelectrics, piezoelectrics, tunable microwave dielectrics, relaxor ferroelectrics, bioferroics and size dependent properties of ferroics and multiferroics, among many others. Bhalla has organized over 70 scientific meetings, conferences and symposia in the field. He has served as Editor, Associate Editor, or as Editorial Board Member on J. Ferroelectrics, J. Integrated Ferroelectrics, J. Materials Research, J. Chem. Vapor Deposition, J. Intelligent Material Syst. & Structures, International J. of Inorganic Materials, and J. Advanced Dielectrics. An ACerS member since 1981, Bhalla has served as Chair of Electronics Division (1992-1993) and ACerS Trustee (1998-2002). He is recognized by the Society Fellow designation (1990), Edward C. Henry Award for 'the best paper of last ten years' (1993) and ACerS Global Ambassador Award (2016). He is also a member or Fellow of several Professional Societies.

Ruyan Guo, Ph.D., F-IEEE, F-CerS, & F-SPIE
Robert E. Clarke Endowed Professor
Electrical and Computer Engineering, College of Engineering
The University of Texas at San Antonio

Prof. Guo has been an active researcher and engineering educator working in the frontier of materials science and device engineering. She conducts cutting edge research in interdisciplinary areas of electronic and optoelectronic materials and devices, more recently on multiferroic nanocomposites, lead-free electronic ceramics, and piezoelectric resonance controlled phenomena, for their advanced functionalities in sensor, actuator, and biomedical applications. She has established her laboratories with state of the art and wide array of dielectric and optical synthesis and characterization capabilities, including ceramic processing and single crystal growth for both materials studies and device development. Over the years Dr. Guo, as a PI or a Co-PI, has been awarded multiple grants and directed many research projects sponsored by NSF, DoD, DARPA, and industries and she has guided more than 60 graduate students to completion in Masters' and Doctorate degree research.

She is the author/co-author of some 440 technical publications, the editor/co-editor of 27 transaction books/professional proceeding volumes, and co-inventor of 6 (including pending) US patents. Her contributions to the understanding of polarization phenomena in ferroelectric solid-solution systems have been recognized in the research community. She has given many invited talks at various domestic and international conferences and organized multiple scientific meetings under the auspice of SPIE, ACerS, IEEE, and IUPAP (International Union of Pure and Applied Physics).

Dr. Guo currently serves as the director for UTSA's Interdisciplinary Graduate Program in Advanced Materials Engineering. Her leadership and professional services also include serving as Director of a NSF funded Research Experience for Undergraduates Site program at the Dept. of EE, Penn State (2003-08), elected Division Chair (2002-03) and then the Division Trustee (2006-09) of the Electronics Division, ACerS, an elected member of the AdCom of IEEE-UFFC (2006-08) representing the ferroelectric community, Chair (int.), UTSA Dept. of Electrical and Computer Engineering (2010-12), and Director (int.) establishing UTSA's Chemical Engineering Program (2016-17). Dr. Guo is also an active member or senior member in AAAS, ASEE, and SWE (Soc. Women Engineers) for which she serves as faculty advisor since 2008. She also serves as a faculty advisor to IEEE-UFFC and SPIE-UTSA student chapters at UTSA.

Prof. Guo holds a Ph.D. in Solid State Science (Penn State, 1990) and a M.S. and a B.S. in Electrical Engineering (Xi'an Jiaotong U., China, 1984 and 1982). She was a faculty member of The Dept. of Electrical Engineering, Xi'an Jiaotong U. (1984-85) and a faculty member of the Materials Research Laboratory, Penn State (1991-99). Prior to joining the faculty of UTSA in 2007, Dr. Guo was a tenured professor of Electrical Engineering of The Pennsylvania State University, being the first woman at the rank of a tenured full professor in the departmental history.

Mr. Brian Mitchell
STEM Education Outreach Coordinator
United States Air Force Research Laboratory Munitions Directorate
Eglin Air Force Base

Mr. Brian "Mitch" Mitchell served as an Aerospace Medicine Specialist in the U.S. Air Force for over 20 years in both active duty and reserve roles before retiring in October 2013. He is currently the STEM Education Outreach Coordinator for the Air Force Research Laboratory's Munitions Directorate. In this role Mitch is responsible for the AFRL Scholars program which provides 50-60 STEM focused students ranging from high school to PhD with 10 week summer internships working directly alongside Munitions Directorate scientists and engineers. He also manages multiple K-12 focused initiatives including AFRL in the Classroom, FIRST Robotics competitions and the Aerial Robotics Challenge all with the goal of increasing STEM literate students with a particular interest in rural and underserved communities. Previously Mitch served as the Munitions Directorate Marketing and Strategic Communications manager.

Mitch was raised in South Florida and travelled the world in the Air Force. He currently resides in Niceville, FL with his wife Shanon and the world's greatest Boston Terriers, Mortimer and Lillian. Both Shanon and Mitch enjoy photography immensely and run their own small photography business. They both also share a strange affinity for all things Disney.

Dr. Kazi Rashed
Engineering Faculty
Engineering Center of Excellence
Houston Community College

Dr. Rashed is working as Instructor of Engineering Department at Houston Community College. He received his Ph.D. in Electrical Engineering from Prairie View A&M University. His Ph.D. research topic was to analyze electrical behavior of Silicon Carbide Power MOSFET devices due to space and terrestrial radiation effects. This research work was required to use NASA world class radiation facilities like Los Alamos National Laboratory and Brookhaven National Laboratory. Dr. Rashed's research group was the first to report measured radiation effects due to high energy neutrons on silicon carbide devices, and results are directly related to applications in the aerospace industry. This was reported in a 2014 IEEE publication.

Dr. Rashed is in touch with the CRESSE (Center for Radiation Engineering & Science for Space Exploration) research group at PVAMU and interested to continue his research on analyzing radiation effects on wide band gap semiconductor devices.

George M. Stancel, Ph. D.
Senior Vice President, Academic and Research Affairs, UTHealth

Dr. George M. Stancel currently serves as the Senior Vice President for Academic and Research Affairs at The University of Texas Health Science Center (UTHealth), a position he has held since 2011.

Stancel came to The University of Texas Health Science Center at Houston in 1972 as an assistant professor of Pharmacology at the Medical School. He has assumed many leadership roles before becoming Executive Vice President for Academic and Research Affairs, including president of the Medical School Faculty Senate, president of the Graduate School Faculty, Chairman of the Pharmacology Department at the Medical School, Associate Dean for Education and Research at the Medical School, Executive Vice President for Research of the Health Science Center, Dean of the Graduate School of Biomedical Sciences, and has served on innumerable committees of the Medical School, Graduate School, and Health Science Center. Stancel notes that he has taught every student who has gone through the Medical School here in Houston and has taught at all six UTHealth Schools and MD Anderson during his tenure. He is especially proud of teaching awards he has received. He has also been active in national professional organizations dedicated to biomedical science and medical education. In addition to being the SVP of Academic and Research Affairs, he is currently Professor of Integrative Biology and Pharmacology at the UT Medical School and Professor of Gynecologic Oncology at MD Anderson (adjunct) and continues to teach pharmacology each year to the medical class.

Stancel's training and research programs have received over $15 million in grants from the National Institutes of Health (NIH) and other sources. His past research has been on the effects of estrogens and related hormones and drugs on the female reproductive system and their role in hormone related cancers although he no longer has his own active research lab since he focuses now on administrative leadership. He has served on a number of research advisory panels and review groups for The National Institutes of Health (NIH) and other professional organizations. He remains actively involved in teaching and research training of graduate students and postdoctoral fellows in UTHealth training programs and those of the Gulf Coast Consortium. He has published over 200 research articles, scientific abstracts, book chapters, and other works.

Stancel was raised in Chicago, and earned a B.S in chemistry from the College of St. Thomas in St. Paul, MN in 1966. He went on to receive a doctorate in biochemistry from Michigan State University in 1970 and did postdoctoral work in physiology at the University of Illinois at Champaign-Urbana for two years. He is married to Mary Lee (Wiepking) Stancel, and they have three children. Mary taught Spanish and English as a Second Language at the high school level for almost 10 years and then taught pre-school at Bellaire United Methodist's School for Little Children for over 30 years where she was selected as the Outstanding Pre-School Teacher of the Year in Houston by the Martel Foundation in 2004. Stancel has been active in scouting and youth sports, and his current hobbies include fishing and biking.

Mr. John Vasselli
Dean, Engineering Center of Excellence
Houston Community College

John J. Vasselli is the Dean of the Houston Community College Engineering Center of Excellence. He possesses over forty years of engineering experience ranging from the Federal research environment, through large corporations, to starting and owning his own engineering businesses. John's career as a scientist, researcher, product developer, and serial entrepreneur gives him a full-spectrum understanding of how to turn a new idea into a global corporation. Three of the companies that John led grew to over $100M/year in annual sales. He holds several patents and degrees in electrical, biomedical and systems engineering.

PROFESSIONAL SUMMARY

- Houston Community College System – Dean, Engineering Center of Excellence
- University of Texas – Director, Houston Engineering Center and Executive Director of TxAIRE Research Institute
- Carrier Corp. – Chief of Technology for Indoor Air Quality & Global Technology Fellow
- Syracuse Center of Excellence for Environmental and Energy Systems – Exec. VP
- Green Star Technologies – Founder & President
- Houston Advanced Research Center - President & CEO
- Syracuse Research Corporation, Director of Corporate Development
- Science Applications International Corporation – Corp. Vice President
- Farmers Mills Technologies – Founder & President
- Air Force Research Laboratory & DARPA Program Manager – Sr. Research Engineer
- United States Air Force – Captain

Staff Members
REEMS & West Houston Center for Science & Engineering

Mr. Bartlett (Bart) M. Sheinberg
REEMS Principal Investigator & Center Director,
West Houston Center for Science & Engineering

Dr. Gi'Zelle Davis
HCC Biology Faculy &
REEMS Faculty Mentor

Mrs. Mary Beth Hurd
WHC & REEMS
Administration

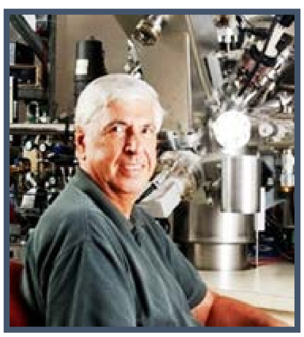
Dr. Sherin Isaac
REEMS Transfer Advisor

Dr. Amanda Hackler
REEMS External Evaluator

The West Houston Center for Science & Engineering
Advisory Council Members

Forrest J. (Jack) Agee, Ph.D.
WHC Council Chair
ADAMCO Inc.

Ron Kelley
WHC Council Co-Chair



Alan J. Jacobson, Ph.D.
University of Houston

Robert Ehrmann
Pennsylvania State University

Carolyn A. Nichol, Ph.D.
Rice University