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# Newsletter

# 2016

## NSF ERC-REVOLUTIONIZING METALLIC BIOMATERIALS STUDENT ASSOCIATION

### From the desk of Director Sankar

Welcome to the seventh student-generated newsletter of the Engineering Research Center for Revolutionizing Metallic Biomaterials (ERC-RMB). Our Gen 3 ERC's mission is to transform current medical and surgical treatments by creating "smart" implants to improve treatments for orthopedic, craniofacial and cardiovascular ailments coupled with the development of a vibrant, diverse workforce well-prepared for the multidisciplinary and global challenges and opportunities of the new millennium.

Our Student Leadership Council (SLC) and student members continue to excel on many fronts as they rally behind the Center philosophy "One Team, One Dream." This SLC report highlights the Center's outstanding accomplishments on multiple fronts. We are truly excited about the intellectual growth and leadership of these ERC students; our next-generation innovators and thinkers.

Our enhanced approach to industrial engagement, in the form of revisions to the Membership Agreement made in 2013-2014, have started to pay excellent dividends. Strong synergistic interactions continued to take place with our industry members, ranging from science to translational to multiple fixed price contract opportunities. Our knowledge in processing and development of various Mg degradable alloy systems, coating technologies, corrosion science, and our testing and characterization methodologies are still our front runners when it comes to

interest from industry, leading to new partnership initiatives. In Year 08, ERC continued to engage with industry and the global community through our routine Friday webinar series. During Year 8, the Center also saw interest and great potential of Mg based systems in other non-medical opportunities such as light weight applications. The center's intellectual merits in understanding alloying and innovation in processing techniques of Mg materials are expected to play important additional roles in the Center's sustainability.

As always, advances in ERC-RMB science have been matched by ERC-RMB milestones in education and outreach. In Year 08, the NCAT BMEN faculty prepared a successful inaugural ABET accreditation visit in Fall 2015 and in Spring 2016 inaugurated the NCAT Student Chapter of the Society for Biomaterials – the 1st in an HBCU (of a total of 18, student chapters nationally). ERC students and staff have garnered national and international recognition and citations. Their accomplishments and leadership achievements are proudly documented on our website <http://erc.ncat.edu>.

On behalf of the entire ERC team, I also take this opportunity to express our special appreciation to our Educational Advisory Board, Clinical and Scientific Advisory Board, and Industrial Advisory Board (EAB, CSAB and IAB) members for their incredible dedication and time.

Again, welcome to our Center. I look forward



to your feedback and participation as we continuously strive to improve.

-Jag Sankar

ERC-RMB Center Director

Welcome to the 2015-2016 issue of the student-generated ERC-RMB newsletter. The ERC-RMB continued to enhance the scientific research progress while simultaneously impacting the local communities with STEM-related activities. The Student Leadership Council (SLC) is pleased to report our Year 8 progress revolving around research activities, education and outreach efforts and student accomplishments.

Featured articles include updates on student

travel and knowledge gained from both national and international conferences. The SLC hosted a standardization workshop at this year student retreat exposing the students to the importance of the development of working standards for characterization of bio-absorbable metallic materials. Graduated students have been able to successfully transition into careers in industry as showcased through the alumni highlights. This year there was momentous advancement made in student research as seen in the abundance of

papers we published, with some selections showcased in this newsletter. The talent in our dynamic center was put on display in a number of recognitions and strong showings in competitions on both research and entrepreneurship.

As always, we greatly appreciate and commend the effort put forth by our newsletter team, editors Jingyao Wu and Adam Chin, as well as the continued support and excellent guidance from the ERC leadership team.

#### SLC Co-Presidents:

**Paul McGhee**  
North Carolina A&T (NC A&T)

**Yonghai Zhang**  
University of Cincinnati (UC)

**Jingyao Wu, Adam Chin**  
University of Pittsburgh (Pitt)



# Events and Activities

## Biomaterials Day 2016 at North Carolina A&T State University

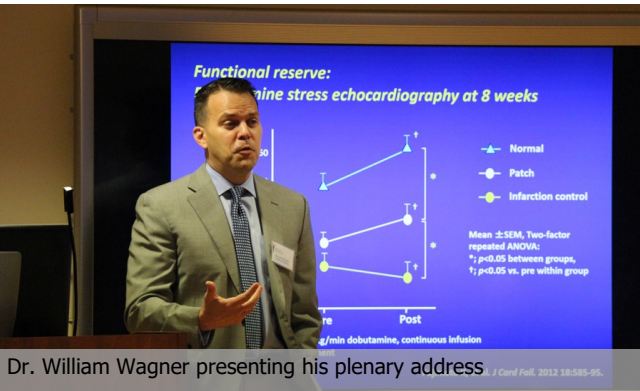
Welcome to the 1st student-generated report of the Biomaterials Day 2016 organized by student chapter of Society For Biomaterials at North Carolina A&T State University. The student chapter of North Carolina A&T State University's Society For Biomaterials hosted Biomaterials Day 2016 as the Chapter's inaugural event

Dr. Stephen B. Knisley, Department Chair and Dr. Jagannathan Sankar, Distinguished University Professor and Director of NSF-ERC-RMB. Three keynote addresses were given by Dr. Jeffrey Macdonald, founder and scientific director of the new UNC Metabolomics and Flux Analysis facility and Co-scientific director of

the NCSU marine MRI & Spectroscopy facility located at Morehead City, NC. Dr. Macdonald's research goal is to combine metabolomics and tissue engineering and apply these tools to quantitative biosystem analysis. His keynote address was on, "Tissue Engineering and System Biology"; Dr. Ahmed El-Ghannam, President of the International Society for Ceramics in Medicine and Director of orthopedic tissue engineering and biomaterials lab. His research interests include coating of metallic implants with SCPC bioactive ceramic, development of bioactive fixation devices and preservation of stem cells in resorbable bioactive scaffolds. His keynote address was on, "Bioceramic Drug Delivery Systems for Cancer Treatment and Regenerative Medicine" and Mr. Wayne Szafranski, responsible for N.C. A&T's intellectual property portfolio and technology transfer operations. His keynote address was on, "Intellectual Property & Technology Transfer".

This Biomaterials Day helped us to promote and explore innovative research being done in area of translational biomaterials especially in degradable metallic implants. The 2016 Biomaterials Day was a perfect opportunity to foster collaborations, networks and relationships to transfer knowledge from academia to industry. Members from different region gave and shared knowledge about biomaterials and biomedical engineering area. During the course of the day there was technical talks from leaders in the biomaterials field, entrepreneurship, process of commercializing products, and the day ended with success stories. Graduate and undergraduate students representing from minority serving institute were essential part of this program. Participants also got an opportunity to know about cutting edge research being done at NCAT especially in the Department of Chemical, Biological and Bioengineering, and Engineering Research Center for Revolutionizing Metallic Biomaterials. This Biomaterials Day program served as a perfect platform to bring scientist and students working on new materials development, materials processing/characterization and modeling, and biocompatibility testing together.

-Nava Rijal (NC&T)



Dr. William Wagner presenting his plenary address

on May 5th, from 8:30 am to 4 pm in Fort-IRC 410.

The 1st Biomaterials Day 2016 hosted by the student chapter at North Carolina A&T State University was a very successful event that brought together interested students and faculty from around the region, leading biomedical researchers, local industry professionals and representatives from local businesses. The biggest highlight of our event was having Dr. William R. Wagner, the Director of the McGowan Institute for Regenerative Medicine as well as a Professor of Surgery, Bioengineering and Chemical Engineering at the University of Pittsburgh for giving the plenary address. Welcome remarks were given by Dr. Joseph B Whitehead, NC A&T SU Provost; Dr. Robin Coger, Dean of College of Engineering;

Dr. Joseph B Whitehead, NC A&T SU Provost; Dr. Robin Coger, Dean of College of Engineering;

This Biomaterials Day helped us to promote and explore innovative research being done in area of translational biomaterials espe-



Student chapter members including faculty and volunteers.

## Annual Student Retreat Highlighted by Standardization Workshop

On April 7-9, 2016, the SLC brought together students at our annual retreat, this time held at Pittsburgh, PA. The meetings began with the research updates from each of the four ERC-RMB research thrusts. This session allowed every student to give a brief presentation on the motivation of their work, show their impactful results, and present their plans for future work. After each presentation, a question and answer session was held to facilitate discussion and potential collaboration. The next component of the retreat was the Standardization Workshop for absorbable metals led by Byron Hayes, who is part of the Biomaterials Research and Development division at W.L. Gore & Associates, an ERC-RMB Industrial Partner. Mr. Hayes began with an overview of the necessity of standards and provided historical precedence for absorbable materials and metals. He then discussed more recent events leading up to the mobilization of groups in ASTM and ISO to develop standards for absorbable metals. He described the standards currently in development (in vitro degradation testing, in vitro biological evaluation, and corrosion fatigue testing) and their importance, and finally how members and students can contribute to the iterative process of their completion. With this background completed, students broke up into groups to more deeply examine the current draft

standards. Based on their research areas, students went through the documents to provide input – making suggestions and comments for modifications and adding essential points that they felt were necessary to ensure the standards may accomplish their goal of identifying what is important for researchers to understand about their materials and how to best evaluate them. The results from each group of this breakout session were compiled and given to Mr. Hayes for inclusion in the ASTM working group discussion. Numerous students have joined the ASTM working group itself to continue to receive updates and contribute to the standards development efforts.

Following the standardization workshop, students went on a tour of the ExOne Company's facilities in nearby Irwin, PA. ExOne provides 3D printed systems and services utilizing binder jetting technology for multiple industry segments, and is an ERC-RMB Industry Partner, collaborating in projects involving 3D printing of ERC-RMB absorbable alloys. Students had the opportunity to learn about the various materials ExOne has the ability to print and what applications they are used for, witness every step of their optimized printing process, and get an inside look into the different generations of printers developed at ExOne. The students took a great interest in the

unique, cutting-edge technology at the



Byron Hayes leading the discussion about stand-

visit, engaging in back and forth discussions with the ExOne employees on site.

During the retreat the students networked and bonded in the distinct Pittsburgh neighborhoods of the Southside Works and the Waterfront and concluded the meeting with internal planning discussions. The retreat was a great success and we hope to build upon the knowledge gained from it for our future gatherings.

- Da-Tren Chou (Pitt)



After a long day of scientific discussions, ERC-RMB students unwind at a neighborhood Dave & Buster's



## A closer look at projects within the ERC-RMB

# Research Highlights

### ***In vivo* monitoring the biodegradation of magnesium alloys with an electrochemical H<sub>2</sub> sensor**

Dr. Heineman's group and other ERC group members have reported a simple and effective methodology to monitor the biodegradation process *in vivo* by sensing H<sub>2</sub> transdermally above a magnesium sample implanted subcutaneously in the mouse model.

We found that the concentration of H<sub>2</sub> in gas cavities associated with rapidly corroding Mg implants was actually very low, even shortly after formation of the cavities. Measurements made noninvasively by just pressing the sensor tip against the skin covering the implant are very similar to those made invasively by inserting the sensor tip inside the cavity. This observation points to extraordinarily fast transport of H<sub>2</sub> through skin. So, we have used the electrochemical H<sub>2</sub> microsensor to transdermally measure the H<sub>2</sub> generated from biodegradation of different magnesium alloys implanted subcutaneously in mice. The measurements are made rapidly and noninvasively by just pressing the sensor tip against the skin covering the implant.

This simple method opens the way to developing H<sub>2</sub> sensing as an effective way to track biodegradation rates of Mg and its alloys *in vivo* and noninvasively.

The H<sub>2</sub> microsensor was used to map out H<sub>2</sub> permeating through the skin (Dr. Dong). Measurements made on the skin on top of the gas cavity, and close to the gas cavity and far away from the gas cavity. The H<sub>2</sub> microsensor response is very fast - less than 1 minute. Some variability in H<sub>2</sub> was found depending on exactly where the tip was placed on the cavity. When the sensor tip was moved off of the cavity, H<sub>2</sub> was still detected from the skin immediately adjacent to the cavity, but at considerably lower concentrations. H<sub>2</sub> levels were correlated with the biodegradation rate of several Mg alloys (Dr. Shanov and Dr. Kumta groups) as determined from weight loss measurements of the implants. H<sub>2</sub> levels correlated with the biodegradation rate as determined from the weight loss measurements of the implants. The microsensor has also been used to measure

H<sub>2</sub> from a Mg stent implanted in an AV fistula in a pig (Dr. Schulz and Dr. Yin groups) and H<sub>2</sub> in bone marrow in a rabbit fracture healing model (Dr. Sfeir and Dr. Shanov groups).

Compared to the conventional monitoring the biodegradation process by micro-CT and X-ray imaging *in vivo*, this new method is noninvasive, fast and requires no major equipment.

-Daoli Zhao (UC)



Dr. Heineman leads the H<sub>2</sub> sensor at ERC

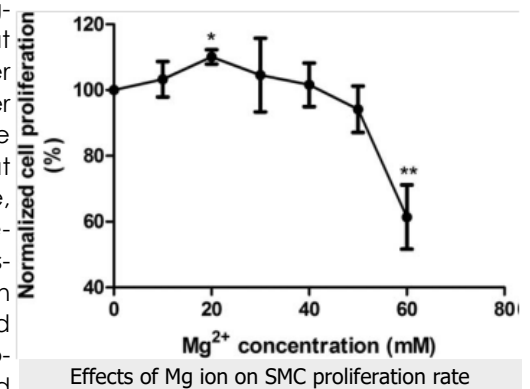
### **NCAT researchers found magnesium ion has biphasic effects on smooth muscle**

Magnesium alloys represent the promising next generation cardiovascular stent materials. However, due to its rapid degradation, high extracellular magnesium ion could accumulate around vascular tissue and exert their effects on vascular cells. Smooth muscle cell is one of the main components of vascular tissue. The proliferation, migration of smooth muscle cells and extracellular matrix (ECM) deposition lead to restenosis, which is a common problem for cardiovascular stent implantation. Therefore, the effects of magnesium ion on smooth muscle cells are of great interest because it can provide information for designing better magnesium alloys to reduce restenosis.

Researchers from Dr. Zhu' at NCAT found the critical magnesium ion concentration for some specific cellular behaviors, such as cell proliferation and cell migration. Combing with our previous study regarding the effects of magnesium ion on ECs, we found that at lower concentration, ECs had better magnesium ion tolerance with higher cell viability and cell proliferation rate compared to SMCs. It indicates that within such a concentration range, magnesium ion could promote re-endothelialization while reduce the possibility of restenosis. Gene expression profiles revealed that most affected genes related to cell adhesion, angiogenesis, inflammation, coagulation and

cell growth. Future research will focus on the effects of magnesium ion on the expression of some important proteins.

-Jun Ma (NCA&T)



## Scientists from UC have been making

Growing of Mg single crystals has been successfully conducted at the UC Nanoworld Laboratory by a research team led by Prof. Vesselin Shanov, which also includes Dr. V. Chaswal, P. Salunke, G. Zhang and M. Joshi. The main reasons of utilizing Mg single crystals in fabricating medical implants is that this approach eliminates grain boundaries responsible for pitting and intergranular corrosion, and also improves the mechanical properties. Successful in-vitro and in-vivo studies have been conducted at UC, U. Pitt and NCAT which confirmed the ben-

efits of using Mg single crystals. Further, it has been found that the anisotropic nature of single crystals allows additional tuning in terms of corrosion and strength in order to match the bone properties. Another interesting finding regarding the Mg single crystals is that unlike most of the polycrystalline metals, this material is extremely ductile and shows superplastic behaviors at room temperature. This means that Mg single crystal implants can bend and absorb impacts without catastrophic failure. Through the years, the UC single crystal

team continues to optimize the growth process in collaboration with the ERC-RMB family. This year we report growing the largest Mg single crystal with diameter of 20 mm and length of 150 mm. As better quality crystals are produced, it is believed that Mg single crystal will find its wide application for manufacturing of different biodegradable medical devices. In addition, our team is pursuing growth of Mg single crystal alloys based on materials provided by U. Pitt (Dr. Kumta) and NCAT (Dr. Xu).

-Guangqi Zhang (UC)



Researchers from Dr. Shanov's lab have been working on scaling up of Mg single crystals throughout the years

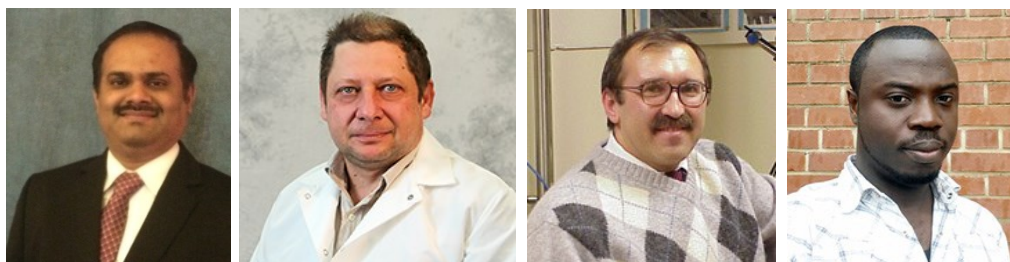
## Pitt-NCAT collaborative study of regulation of Magnesium corrosion by a self-assembled alkylsilane coating

Recently, Mr. Avinash Patil, a PhD student at Pitt's BioE department visited the NCAT University to work on a collaborative project. He works with Dr. Elia Beniash, an associate professor at Department of Oral Biology, School of Dental Medicine of Pitt. Avinash and Dr Beniash are members of the Center for Craniofacial Regeneration. As a part of his PhD work, Avinash works on controlling the corrosion rate of degradable Magnesium (Mg) and its alloys by coating with alkylsilane. To better understand how the coating controls the corrosion rate of the underlying Mg substrate, he needed to investigate the mechanism of alkylsilane layer degradation. Dr. Sergey N. Yarmolenko, senior research scientist, Center for Advanced Materials and Smart Structures, North Carolina A&T State University, has developed a unique set-up for real time quantitative magnesium corrosion studies, which could provide answers to Avinash's questions. Avinash went to NCAT where together with D. Yarmolenko and his postdoc Dr. Ruben Kotoka conducted a series of experiments. They used optical density method to assess the corrosion rate of Mg and the patterns of corrosion propagation. They used optical mi-

croscopy to observe corrosion of thin layer of Mg under transparent alkylsilane coating. The Mg substrate was produced by evaporation deposition of 100 to 300 nm thick layer of Mg on glass cover slips. These Mg coated glass cover slips were further coated with an alkylsilane layer to mimic an alkylsilane coated Mg medical device. Immersion tests were performed at 37°C in phosphate buffered saline solutions. The result showed that degradation rate of Mg depends on integrity of Alkylsilane layer with Mg substrate. Small submicron defects in the coating become initial sites of corrosion. We can classify coatings as degradable, since it interacts with media and allows access to substrate after degradation. Corrosion reaction with Mg substrate lead to degradation of interface between

coating and substrate (loosening) which eventually lead to cracking and peeling off of the coating. Above work lead to further investigation of mechanical properties of the coating, and specifically its adhesion properties. Dr. Sudhir Neralla from Jet-Hot High Performance Coating is further investigating the adhesion properties of Alkylsilane layer to Mg substrate by nanoindentation technique. Dr. Ruben Kotoka and Dr. Sudhir Neralla were very helpful to assist Avinash in completing experiment on time. At the end of the trip, Avinash presented his work at ERC/BMEN seminar series of NCAT titled "Self-Assembling Organosilane Coating for Resorbable Magnesium Biomedical Devices".

-Avinash Patil (Pitt)



From left to Right, Mr. Avinash Patil, Drs. Elia Beniash, Sergey Yarmolenko and Ruben Kotoka



## NCA&T student became Student Trainee (Engineering) at FDA

As an Engineering Student Trainee with in the Food and Drug Administration (FDA), I've become a part of a team of scientist and engineers that contribute to protecting public health of citizens. Being at FDA has allowed me to gain more knowledge about regulatory science and regulation of medical devices. My role as a student trainee is to conduct science-based research to determine the accuracy and effectiveness of blood pressure monitors. While conducting this research, I gained valuable skills and knowledge that has helped me develop a better understanding of medical devices in conjunction with being a biomedical engineer. I have also gained experience in the regulation of medical devices by becoming a biocompatibility consultant in the Office of Device Evaluation. As a biocompatibility consultant I've had the chance to review submission from sponsors and evaluate the biocompatibility

testing conducted on their medical devices. This experience by the FDA has allowed me to learn more about the regulatory process companies must follow in order to have their medical device cleared or approved by FDA. As a part of this job, I had to become familiar with the ISO 10993 (Biocompatibility) standard in order to make the best decisions regarding the safety and effectiveness of the subject device. As a consultant, I interact with many intellectual individuals in a group setting, which specialties include chemistry, microbiology, immunology, medicine, toxicology, engineering, and statistics. I am able to learn from these individuals and apply the knowledge to my review process and understanding of different areas of science. North Car-

olina A&T State University, specifically the ERC, has prepared me for this job by introducing me to research involving medical devices on the market today. I believe this opportunity benefits the ERC because it has helped establish a relationship between FDA and ERC, which would further encourage collaboration for future research.

—Latecia Anderson-Jackson - (NCAT)



Latecia presented her poster about FDA work experience

## ERC-RMB Students Part of Winning Team in PHICC 2016

Two University of Pittsburgh Bioengineering graduate students and researchers in the ERC-RMB, participating in a team of 4, were victorious in the 3<sup>rd</sup> Annual Pittsburgh Health Innovation Case Competition (PHICC), taking home a

combined \$4000 prize. SLC members Jingyao Wu and Da-Tren Chou, along with their Pitt Bioengineering peers Eric Jeffries and Jingming Chen were tasked with providing a solution to a critical business problem encountered by a medical fitness wearable company.

the competition, teams presented to a panel of judges comprised of specialists in the fields of technology entrepreneurship, consulting, commercialization, and bioengineering, coming from global firms such as McKinsey and Company and Navigant Consulting, as well as local organizations such as Innovation Works. With the assembled group of judges and sponsors, the case competition also provided networking and recruiting opportunities for participants to connect with industry members.



Two ERC students Jingyao Wu (second from right) and Da-Tren Chou, teamed up with other Pitt bioengineering students nailed PHICC.

In this unique health care-focused case competition, 12 selected teams from universities throughout Pittsburgh were given a week to conduct research and craft a presentation to communicate their framework and recommendations. On the day of

The success of the ERC-RMB students involved is yet another indication of the entrepreneurial spirit and well-rounded background that the center has imparted on its trainees.

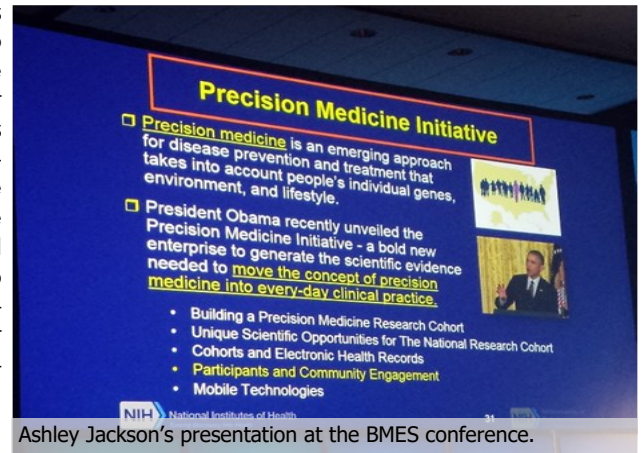
- Da-Tren Chou (PITT)

## Ashley Jackson wins travel grant to attend BMES Annual Meeting

Ashley Jack, a graduate student won a travel grant to support her to attend this year's BMES Annual Meeting at Tampa, Florida. The BMES Innovation and Career Development Travel Award provided a unique opportunity for attendance at the 2015 BMES Annual Meeting in Tampa, Florida. This award is particularly geared toward underrepresented graduate students, post-docs, and early career faculty and professionals in an effort to increase event participation and diversity. More specifically, the award is targeted to individuals doing research in minority health and health disparities. As a member of the ERC, especially com-

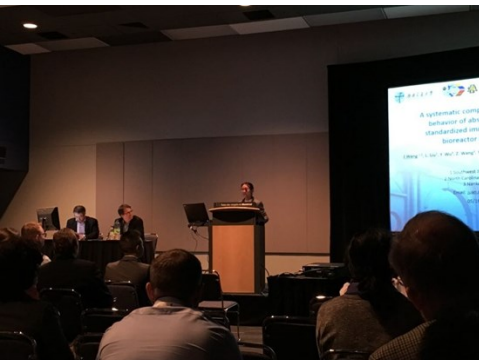
ing from an HBCU, this was an amazing opportunity to discover more about the health inequalities that inhibit the growth and awareness of minority populations today. I believe that one of the goals of the ERC is to include investigation of personalized medicine, and that lines up quite perfectly to help overcome the inequity that plagues our minority population today.

- Ashley Jackson (NCA&T)



Ashley Jackson's presentation at the BMES conference.

## Lumei Liu's collaborated work wins presentation award at WBC 2016



Dr. Juan Wang presented her work partially done at ERC during WBC, Montreal, Canada

biodegradability and biocompatibility. However, Mg degradation and its fate in terms of toxicity are not still known. The discrepant outcomes of Mg-based alloys between in vivo and in vitro tests made the corrosion behavior unpredictable. To better evaluate Mg-based alloys, it is necessary to identify relevant factors of in vitro models that mimic as closely as possible the in vivo microenvironment.

In recent work focusing on this issue, Dr. Juan Wang, who gave a wonderful presentation in the 10th World Biomaterials Congress (WBC) after working in the lab of Dr. Yun at NC A&T, exemplified the drive and passion for success of the ERC-

RMB with a large research collaboration net. In their work, she collaborated with Ms. Lumei Liu in both ex vivo and in vivo test. In their study, an ex vivo model with porcine aorta was first developed to study Mg biodegradation behavior using an aorta bioreactor, comparing with which, in vitro standardized immersion and in vivo assessments to test biodegradation behavior of pure Mg wire are systematically investigated and correlated at 3<sup>rd</sup> day and 5<sup>th</sup> day. This work was the award winner for this presentation.

- Lumei Liu (NCA&T)

Magnesium (Mg)-based stents can be used to treat atherosclerosis due to its

## Nava Rijal, Recipient of \$5000 from Society For Biomaterials & Winner of 5th Annual Graduate Student Research Poster Competition

Mr. Nava P. Rijal, who recently defended his Master's Thesis after working in the lab of Dr. Bhattarai at NC A&T, exemplified the drive and passion for success of the ERC-RMB with a number of achievements over the past year. As Founding President for student chapter of Society For Biomaterials, Nava was one of vital person to initiate this chapter toward success. The student chapter of Society For Biomaterials at North Carolina A&T State University received \$5000 to host a 1st Biomaterials Day. Application for this external grant was initiated by Mr. Nava P. Rijal (Founding President) and Dr. Narayan Bhattarai (Chapter Advisor) along with other chapter officers. This was one of the first grant in minority school ever

received to host the Biomaterials Day. Mr. Rijal also received a number of re-



Mr. Nava Rijal during poster presentation organized by College of Engineering.

search accolades, including winning first place (\$400) at the 2016 NC A&T College of Engineering poster competition. His poster was titled, "Innovative Processing of Magnesium-Polycaprolactone-Based Electrospun Nanofibrous Scaffold". The ERC-RMB is proud of the impact that Rijal has made in research and through his leadership and his example is one that we hope other students in the center will follow.

—Nava Rijal (NVAT)

# FACULTY ACHIEVEMENT CORNER

The SLC would like to acknowledge some of the accomplishments of our outstanding faculty. It is through their leadership, encouragement, and guidance that we as a student body are able to always perform to our



DR. HARVEY BOROVETZ

Review Panel, Whitaker International Fellows & Scholars Program

Clinical & Scientific Advisor - Executive Committee, FDA Consortium - Philadelphia Pediatric Medical Device Consortium

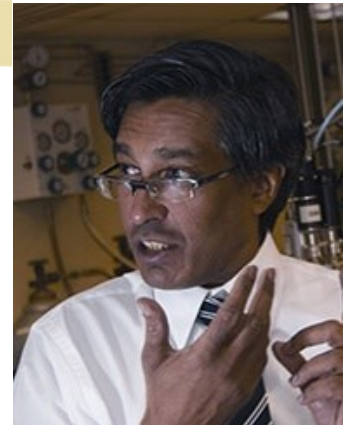
"Long-Term Mechanical Circulatory Support in Children"  
Graduate Seminar, Department of Biotechnology Engineering, Ort Braude College, Karmiel, Israel

DR. JAGANNATHAN SANKAR

North Carolina's highest civilian honor by the Governor "the Order of the Long Leaf Pine"; 2015

NSF "Science Nation" video broadcast for the global audience

Inducted into the AIMBE College of Fellows for education and outreach contributions towards the establishment of the BMEN programs at NCAT.



DR. WILLIAM WAGNER

Plenary Lecturer, Biomaterials International, Kenting, Taiwan 6/1/2015

Keynote Speaker, Summer Undergraduate Research Seminar, Pennsylvania State University 7/1/2015

Elected International Fellow, Tissue Engineering and Regenerative Medicine International Society (TERMIS) 9/1/2015

DR. DEVDAS PAI

Inducted into the AIMBE College of Fellows for education and outreach contributions towards the establishment of the BMEN programs at NCAT.



DR. SARAH PIXLEY

Nominated for the Mrs. Dolly Cohen University of Cincinnati College of Medicine Excellence in Teaching Award. 2016, for medical school teaching.

President, University of Cincinnati Sigma Xi Chapter, 2015-2016.

Awarded Grant: from the University of Cincinnati LEAF NSF program.







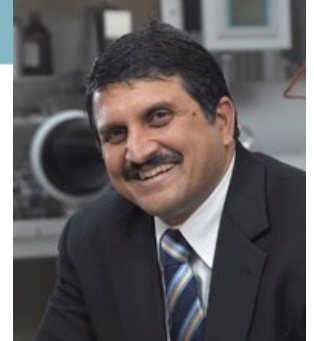
DR. MARK SCHULZ

Gave ten seminars on the Expanding Medical Device Development and Sustaining the ERC

DR. PRASHANT KUMTA

Recognized with the Advanced Manufacturing & Materials Award among ten Carnegie Science Award winners in science and technology

Featured in and interviewed by several magazines and newspapers such as Pittsburgh Post-Gazette article on ERC related research.



DR. YEOHEUNG YUN

First graduate coordinator for Bio Engineering Program

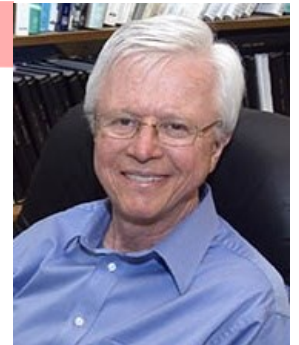
Received several grants including NIH SC3 grant, DoD instrument grant and DTRA grant

DR. WILLIAM HEINEMAN

Received the ACS Analytical Division Distinguished Service Award in 2015

Received ACS national Award in Analytical Chemistry, 2016

Invited speaker in symposium on Magnesium-based Biodegradable Implants - Corrosion/Market and Clinic at TMS 2016 in Nashville 2016



DR. SAVIO WOO

Appointed as the Bao Yu Gang Endowed Chair Professor (2016-2018) at Ningbo University in Zhejiang China

Recognized by the American Society of Mechanical Engineers (ASME) with the creation of the Savio L-Y. Woo Translational Biomechanics Medal

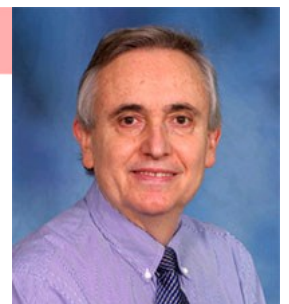
Honorary Professorship from Ningbo University and Zhejiang University in China

DR. VESSELIN SHANOV

New Grant from ARMY: Cooperative agreement: Cooperative Agreement: Nano Antennae for Army Applications

Four invited presentations per below:

New Grant in progress with Cook Medical: Chemical Etching of Unpolished and Polished Mg-Nd Stents



# Education and Outreach



North Carolina  
Agricultural and Technical  
State University

Another year of outreach activities to local elementary, middle, and high school students was accomplished this year at NC A&T!

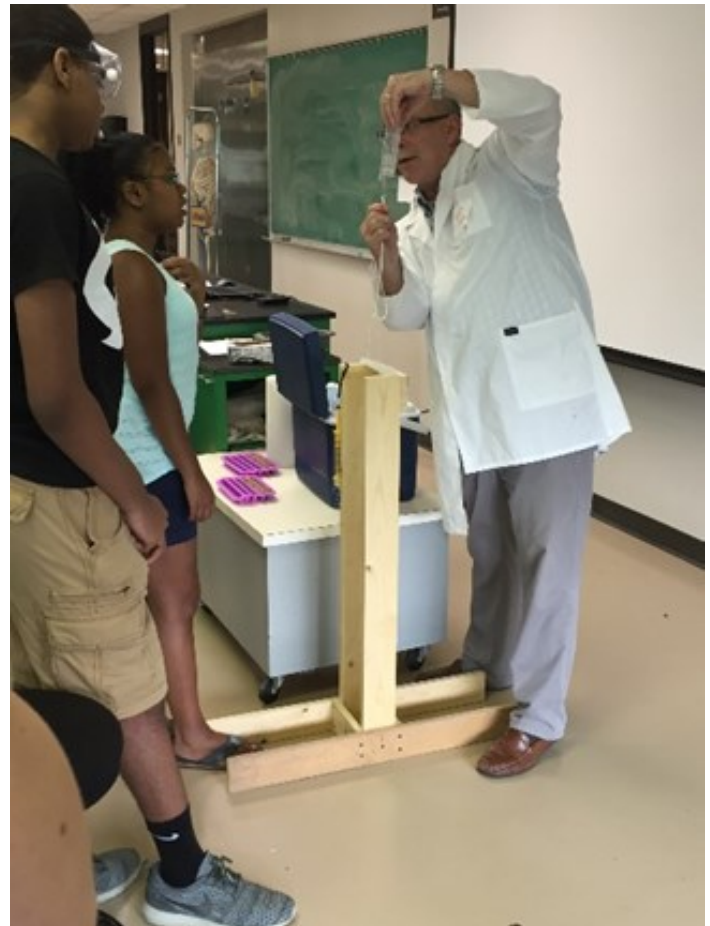
## 2015 Brain Games

NC A&T and SLC graduate student continue to push the STEM-related outreach activities out to the local elementary, middle, and

high school students. The B.R.A.I.N (Bioengineering Recruiting and Interactive Network) Games was hosted at NC A&T on July 28, 2015. Coordinated by Dr. Matt McCullough and Dr. Vernon Alford, ERC-RMB students helped RETs (Research Experience for Teacher) to run their modules in order to expose the 17 high school participants to hand-on bioengineering experiments involving thin film technology, nanofiber technology, aspirin mechanism, and etc.

## Claxton Elementary School – Science Extravaganzas

NC A&T SLC members made their way to the Claxton Elementary school to volunteer at the 2016 Science Extravaganza on April 26, 2015. This event is supported by representatives from Caterpillar, ASME, and NC A&T undergraduate mechanical engineering and bioengineering students. The focus of this year's Science Extravaganza was "Puff-Puff Mobile", which involved students to used engineering design, team work, and testing to developed awesome "puff-puff" mobile. Claxton's students were exposed to using scientific methods, engineering design techniques, and how to utilize their initial working materials to accomplish their design goals. ERC-RMB SLC members provided guidance throughout the mobile development process while also encouraging the future STEM leaders to think and perform like genuine engineers that they will become one day. Students overcame the design flaws as they work on ensuring the ideal mobility of their puff mobile in



RET Kent Boyles from Kernolde Middle School demonstrate module to the students.

order to achieve the longest distance in ten seconds.

-Paul McGhee (NC A&T State University)



Udhab Adhikari and Paul McGhee assisted students with their puff mobile design.





During Year 8, ERC-RMB students of the University of Cincinnati participated in outreach activities for junior high school students at Mt. Healthy Junior/Senior High School. Ms. Roni Dean, a 7th grade science teacher at the school has maintained a long term outreach cooperation with ERC-RMB students at the University of Cincinnati. On December 21, 2015, ERC students Kolade Ojo, Yonghai Zhang, Professor Sarah Pixley and students from her department participated in an event to teach a class of basics of human brain and nerve systems. Vivid presentations were given to the 7th graders. Animal and human brain and nerve system sample models have been shown to the 7th graders. The 7th graders were excited to learn about how the brain controls our body movement and how the nerve system works to transport nerve signals.

- Yonghai Zhang (UC)



Dr. Sarah Pixley and ERC students at UC give a lecture to a group of high school students about human brain and nerve systems



## University of Pittsburgh

One of the goals of ERC-RMB is to train the 21st century STEM (Science, Technology, Engineering and Mathematics) workforce (pre-college and college) and provide students with technical education relevant to 21st-century careers in advanced processing, bioengineering and materials – a workforce that can compete with any worker in the world.

To fulfil this goal a team of ERC-RMB students from Pitt presented their work in the University of Pittsburgh's Health Career Scholars Academy (UPHCSA) summer program to educate high school students from Pittsburgh region. Karen D. Narkevic, the UPHCSA director approached three ERC-RMB

senior PhD students from Bioengineering department of Pitt, Avinash Patil, Jingyao Wu and Adam Chin to present their work to students participating in 2015 program. The Academy is often a springboard for future studies in medicine. Approximately 110 talented young men and women students between ages 15-18 are selected from high school each year. The main aim of the presentation was to introduce the high school students about metal and its alloys, medical device and corrosion of implants. Students learned about exciting work taking place at Pitt's ERC-RMB program. After every presentation students asked very challenging questions about degradation of Magnesium and how it will be used as medical device material in clinic. Overall, it was exciting experience to participating students to know more about degradable Magnesium devices.

- Avinash Patil (Pitt)



ERC students, Adam Chi, Avinash Patil, George Hung and Jingyao Wu, at Pitt gave a lecture about biodegradable metals at UPHCSA summer program

# Conferences

*ERC-RMB travels the world to present its discoveries*

## ERC-RMB Represented at the 2015 ASME IMECE Conference in Houston, Texas

The 2015 American Society of Mechanical Engineering (ASME) International Mechanical Engineering Congress and Exposition (IMECE) was held at the Hilton Americas and George R. Brown convention center in Houston, Texas from November 13-19, 2015. This conference brought together members of academia, industry, and government to discuss a broad range of Mechanical Engineering topics. The 2014 Congress theme was Engineering for in Medicine and Healthcare which included 20 multidisciplinary tracks with over 2,200 presentations.

The innovations in processing, characterization, and applications of bioengi-

neered materials was represented by the ERC-RMB. Research accomplishments of the ERC-RMB were presented by graduate students Udhab Adhikari, Nava Rijal, Nana Kwame Yamoah, and Paul McGhee (NC A&T) and NC A&T faculty.

The conference keynote speaker was William E. Cohn, MD, who is director of the Center for Technology and Cullen Cardiovascular Research Laboratory at the Texas Heart Institute. Dr. Cohn is also associate director of Laboratory Surgery Research in the Center for Cardiac Support. Aside from research, Dr. Cohn is a professor of surgery at Baylor College of Medicine and an adjunct professor of bioengineering at both Rice University

and the University of Houston. Dr. Cohn gave an encouraging talk on how engineering help enhance the field of medicine such as his development of the continuous-flow totally implantable artificial heart. Plenary speaker. The conference lasted 7 days filled with numerous social and scientific events. At the conclusion of each day, there were opportunities to explore various tourist sites and local restaurants in downtown Houston.

The 2016 ASME IMECE will be held in Phoenix, Arizona on November 11th - 17th, 2016 and is another chance for the ERC-RMB to continue to illuminate its strong presence.

- Paul McGhee (NC A&T)



Dr. Cohn taking answering question from the audience at the ASME conference. (b) From left to right: Nana Kwame Yamoah, Nava Rijal, Dr. Bhattarai and Udhab Adhikari present at the 2015 ASME IMECE conference in Houston, Texas.



## NCA&T Student Represented at Nano Manufacturing 2015 Conference

Mr. Shalil Khanal, ERC RMB student at NCAT, presented his work titled "Chitosan coated PLGA micro/nano particles for Drug Delivery" at Nano Manufacturing 2015-Conference. The conference was held on September 30, 2015 at the Joint School of Nanoscience and Nanoengineering (JSNN) on the South Campus of Gateway University Research Park in Greensboro, North Carolina, USA. The primary goal of that conference was, to bring together Founders, CEOs, Senior Executives, Business

Leaders, Economic Developers, Educators, Government and Nonprofit Organization Executives to share their vision for the future and the opportunities that Nano Manufacturing enables.

Attendees came from Quebec Canada, Massachusetts, Georgia, Virginia, Maryland, Florida, New Jersey, and North Carolina. There were 15 speakers from industry, government, academia, and small medium size businesses to global corporation presented their nano manufacturing innovation and commer-

cialization. As well as, there was a product exhibition from different vendors. This Conference provided him a real opportunity to share knowledge and foster collaborations, networks and relationships and also to learn about advanced technologies in synthesis and characterization of nanomaterials and how the application of these new technologies can help grow the manufacturing sector in North Carolina and the whole nation.

-Shalil Khanal(NCA&T)

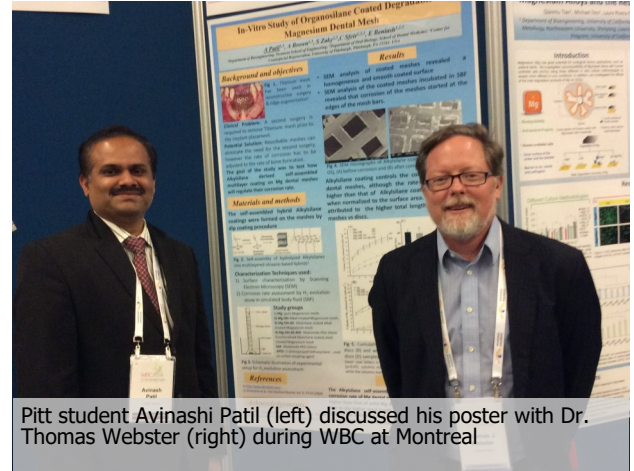
## ERC Students Presented their work at Biometal conference and WBC

This year's Symposium of Biodegradable Metals was moved to May right before the 10th World Biomaterials Congress (WBC). Several ERC professors and students attended the meeting. Dr. Shanov from UC gave a keynote talk on Magnesium Single Crystal for Biodegradable Implant Applications. Dr. Kumta presented the *in vivo* work from his lab on ERC alloys for orthopedic application. Pitt student Jingyao Wu present his poster on Mg stents for airway stents application. ERC alumni, Dr. Juan Wang from NCAT gave a talk on analysis on Mg corrosion.

Same as the Symposium of Biodegradable Metals, the 10th World Biomaterials Congress (WBC) was held at Palais des

Congres convention center in Montreal, Canada from May 17-22, 2016. This conference brought together members of academia, industry, and government to discuss a broad range of biomaterials topics, covering from materials development through to the use in patients.

The ERC-RMB represented the biodegradable metals and polymers community, with graduate students Avinash Patil, Chris Mahoney as well as Drs. Vesselin



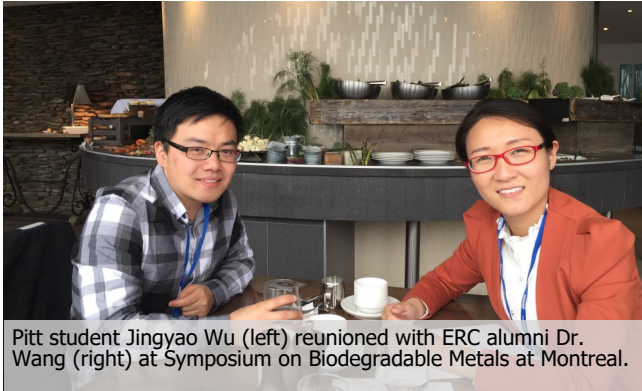
Pitt student Avinashi Patil (left) discussed his poster with Dr. Thomas Webster (right) during WBC at Montreal

Shanov, Frank Witt, Xinyan Cui, Zhigang Xu, William R. Wagner, Xinzhu Gu. Avinash Patil, a PhD student from Pitt presented a poster titled "In-Vitro study of Organosilane Coated Degradable Magnesium Dental Mesh". Dr. Xinzhu Gu presented her work on polymer coating on Mg vascular stents.

The plenary sessions were remarkable, presented by Profs. Fionna Watt, Jiang

Chang, David Mooney, Kazuhiko Ishihara, David Tirrell, covering topics from stem cells to cancer vaccines to protein science and engineering. Attendees also had the chance to network and socialize at the congress party, where they were treated to a night fun with cities finest culinary delights and artistic performances. At the conclusion of each day, there were opportunities to explore various tourist sites and local restaurants in downtown Montreal.

-Xinzhu Gu, Avinash Patil, Jingyao Wu (PITT)



Pitt student Jingyao Wu (left) reunited with ERC alumni Dr. Wang (right) at Symposium on Biodegradable Metals at Montreal.

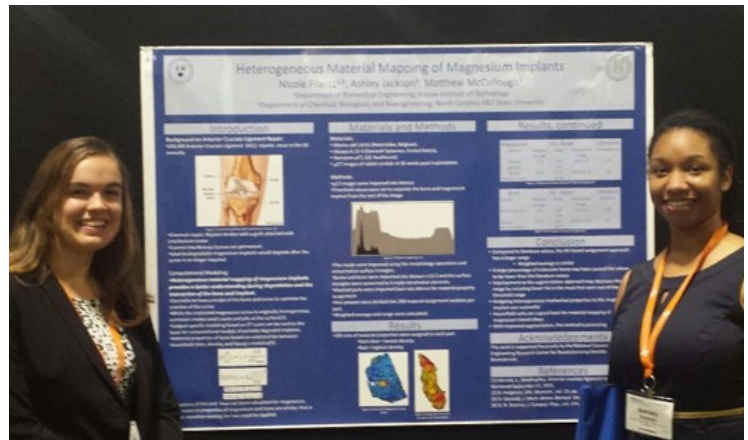
## ERC-RMB Represented at the BMES Annual Meeting in Tampa, Florida

The 2015 BMES Annual Meeting in Tampa, Florida themed, "Innovation at the Interface" was a dynamic conference filled with many networking and learning opportunities. A few of the workshops and sessions included the BMES-NSF Special Session on Research in Biomedical Engineering and Grant Writing, a Celebration of Minorities in BME luncheon as well as Women in BME luncheon. The annual meeting also provided undergraduate researchers a chance to display and present their work in their Undergraduate Research, Design and Leadership sessions. Two of our ERC REUs from the previous summer presented their work there; Erika Benlisa and Nicole Frantz. Erika presented the work she completed with Dr. Yun and Dr. Koo entitled "Surface Morphology of Magnesium Based Alloys in a Simulated *in vivo* Environment Using Microfluidics," and Nicole discussed work done with Dr. McCullough and myself entitled, "Heterogeneous Material Mapping of Magnesium Implants".

The two most memorable events for me included the grant writing session and the Biomedical Engineering Technology for the Elimination of Health Disparities plenary. These were both very passionate and informative sessions. The grant writing session was a small, round table workshop where we met with representatives from both industry and academia. It was interesting to hear the innovative thinking of all the participants. The health disparities plenary involved a forum-like discussion where the participants were given a chance to voice their opinions as well as ask questions about the research that the presenters were doing. I personally had the opportunity to

talk with orthopedic surgeon Dr. Cato Laurencin, an accomplished and distinguished surgeon and researcher. To me, that opportunity alone was worth it! We discussed health disparities and shared thoughts on what we considered the most challenging areas to overcome in the African American community.

—Ashley Jackson (NC A&T)



Ashley Jackson presented her work at the BMES Annual Meeting

# ERC-RMB

## Graduating students & alumni

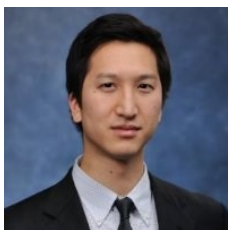
Bright young scientists move on to the next saga of their promising careers



### What did you take out of your experience being a part of the ERC-RMB?

#### Da-Tren Chou (Pitt)

Da-Tren graduated with a Ph.D. in Bioengineering in 2015. Dr. Prashant N. Kumta was his adviser. He is joining the consulting firm McKinsey & Company as an Associate.



"The ERC-RMB opened various paths that I would not have been able to explore under any other program. From the elevator pitch competition which initiated my interest in business, to participating in Student Retreats where we learned from external experts, to the vast multidisciplinary research I took part in, the center allowed me to gain skills and experiences valuable for a variety of career options."

#### Katie Farraro (Pitt)

Katie received her Ph.D. in bioengineering with a concentration in biomechanics under Dr. Savio L-Y. Woo at the Musculoskeletal Research Center (MSRC). She is currently a post-doctoral researcher at the MSRC and Naton Institute of Medical Technology, and plans to pursue a start-up company based on her doctoral work as part of ERC RMB



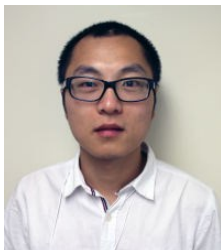
"My experience in the ERC has been pivotal in my graduate school experience and post-graduation plans. Not

only did it give me the great experience to meet and collaborate with a multi-

disciplinary group of some of the brightest minds in this field, it provided me with excellent networking and professional development opportunities and helped me to realize the importance of translational research as well as my own passion for entrepreneurship."

#### Jun Ma (NCA&T)

Jun graduated with an M.S. degree in Bioengineering in the 2015 working under Dr. Donghui Zhu. He will be pursuing a Ph.D. in Biomedical Engineering at the University of Miami beginning in the fall of 2016.



"The ERC-RMB provided me the opportunity to collaborate with people in different research fields. The highly translational research made me feel that what I did in the lab could impact people's lives. And the hands-on lab experience prepared me well for my future graduate study."

#### Nava P. Rijal (NCA&T)

Nava graduated with an M.S. degree in Bioengineering in spring of 2016 as part of Dr. Bhattarai's lab. He will be continuing his Doctor of Philosophy in Biomedical Engineering program at University of Cincinnati starting fall of 2016.

"I am heartily grateful for the opportunity in becoming part of NSF-ERC- RMB family. This opportunity provided me with tools that allowed me to excel in academia as well as leadership and networking field. Past two years in the ERC, I not only was



able to finish my degree, but also published several research papers as the lead author and co-author and played a significant role in hosting Biomaterials Day 2016. The hands-on experience in research has well prepared myself for my long term goals and dreams, and I always cherish new friends and colleagues our NCAT team has forged through ERC."

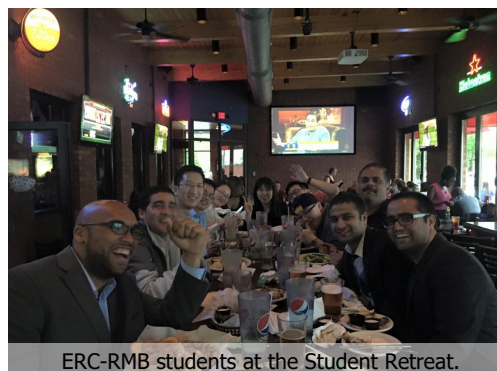
#### Daeho Hong (Pitt)

Daeho graduated with a Ph.D in Bioengineering at the University of Pittsburgh under the direction of Dr. Prashant N. Kumta. He is currently looking for the opportunities to work in the field of medical device and additive manufacturing.



"ERC-RMB provided me to work in collaboration with great researchers who helped me develop biodegradable alloys for medical device applications. I could involve in various projects and learn

different aspects of biomaterials and medical device research. My experience at ERC-RMB prepared me well to make a transition to my career in translational medical research."



ERC-RMB students at the Student Retreat.