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Upcoming Events in 2015

7 December, 5:30 PM
 Buca di Beppo (St.Paul)
 Dinner and discussions
 Talk with Luke Hanley from the University of Chicago
Title: "Mass spectrometry imaging using laser ablation: from ultrashort pulses to portable instruments"

For more events and dates please check our website

<https://www.avs.org/Chapters/Minnesota/Future-Events>

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Opening Note

Dear MN AVS Friends,

Welcome to the fall edition of the MN AVS chapter newsletter. The chapter has been very active over the past couple of months and we are very excited to showcase our accomplishments and activities. Hopefully you participated in at least one chapter event. The Fall Symposium was an enormous success and Ali Rafati will highlight the event in more detail in this newsletter.

I'm also very excited for the newly formed AVS Student Chapter at the University of Minnesota.

Congratulations to Christopher Cheng (U of M student) and Bharat Jalan (faculty advisor) for taking the initiative to lead this effort.

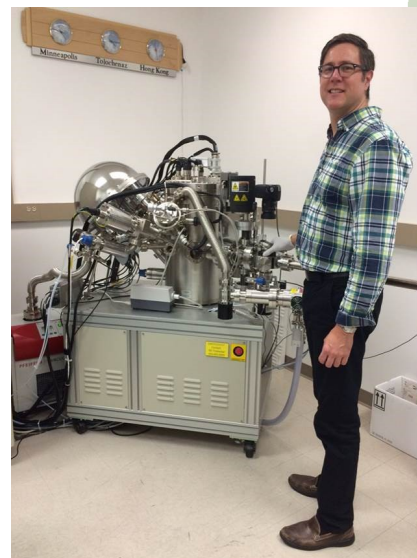
I encourage all of you to join the MN AVS group on LinkedIn to stay current on future chapter activities. To date we have over 132 members! Please bookmark the MN AVS Chapter website as well.

The next chapter meeting is scheduled for December 7th at Buca di Beppo. Luke Hanley from the University of Chicago is our featured guest. He will be enlightening us on "mass spectrometry imaging using laser ablation: from ultrashort pulses to portable instruments". I hope to see you there!

Sincerely,
 Bill Theilacker
 Chair

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To advertise in this newsletter, please contact todd.tevogt@gammavacuum.com



2015 Minnesota AVS Science Educator

Stephanie Marsh, a Moose Lake High School Physical Science, Physics, and Chemistry teacher, was selected to attend the 2015 Science Educators Workshop, held in conjunction with the 2015 AVS International Symposium.

There were five well qualified applicants this year, continuing a trend of increased interest in this program over the recent past. Stephanie earned a BA in Chemistry, A BS in Science Education, and a M.ED. in teaching and learning and has been teaching since 2001.

As our Short Course program in the spring of 2015 was quite successful, we hope to be able to send two teachers to the 2016 Science Educators Workshop. The Minnesota Chapter of AVS has sent a teacher to this annual event for many years, and all have given the workshop very high marks. The teacher's school district receives a vacuum system suitable for basic demonstrations and experiments at no cost, and the local chapter covers expenses for the teacher to attend, including air fare, hotel and meal costs.

Are you interested?

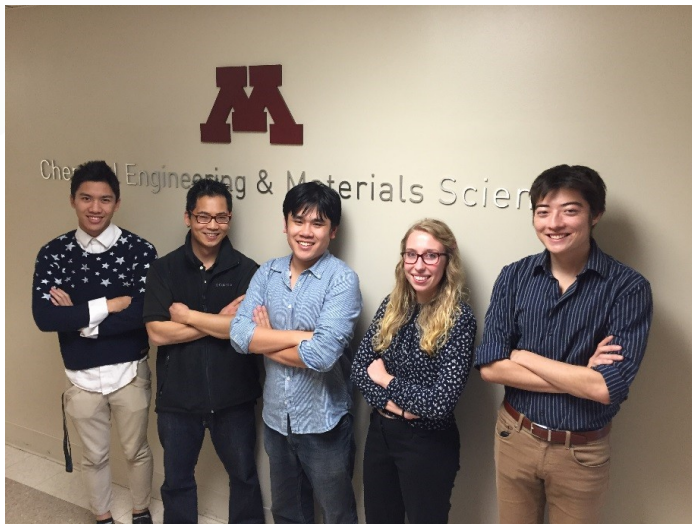
Any teacher interested in applying for this workshop is encouraged to watch for the application announcement on the AVS website:

<http://www.avs.org/Education-Outreach/Science-Educators-Workshop>

For more information please contact Del Smith at:

delmer.smith@normandale.edu

AVS STUDENT CHAPTER SUMMARY



The AVS student chapter officers, from left to right: Joey Treul, Will Kramlinger, Chris Cheng, Paige Holgate, Sean Nichols. (Not pictured: Ian Hamerlinck, Ryan Chan). The student chapter is advised by Dr. Bharat Jalan.

The American Vacuum Society at the University of Minnesota, Twin Cities Student Chapter has recently been formed, and has already begun to generate some interest and dive into the sciences. In late August, they engaged with several incoming freshmen to promote the student chapter at the University of Minnesota College of Science and Engineering Welcome Week Student Organization Fair. They gained interest from more than 50 students in a wide variety of engineering majors, such as Chemical, Materials, Mechanical, Biomedical, and Civil, just to name a few. They have also reached out to several other groups for future collaborations, such as Materials Advantage, the American Institute of Aeronautics and Astronautics (AIAA) Minnesota Student Chapter, TeslaWorks, etc.

Only two months into their formation, the student chapter dove into the sciences, forming two major year-long projects. The first is, in collaboration with the AIAA Minnesota Student Chapter, to enter the SpaceX Hyperloop Pod competition. The goal of the project is to design a transport system/pod, incorporating reduced-pressure tubes while the pods ride on a thin layer of air. More specifically, the student chapter is working on the material performance and design of the air bearing systems of the pod.

The second major project is part of an outreach program to intermediate and middle schools the student chapter plans to undergo the next few years. The goal of this project is to design a vacuum apparatus that will essentially freeze dry ice cream so that the ice cream won't melt on a regular day, but would melt in your mouth: a child's dream. The team consists of a wide variety of majors, including the material engineers working out the complexities of chocolate phase diagrams and the chemical engineers working on optimizing the pressures and thermodynamics of the system.

In addition to these major projects, the student chapter has also begun to set up major events. They have set a huge networking event on November 13th, inviting companies from all over to come and enjoy food as well as for engineering students and industry to get to know one another.

STORY OF Stephanie Marsh (Attendee of 2015 AVS Science Educators Workshop)

My name is Stephanie Marsh and I was selected to attend the 2015 AVS Science Educators Workshop (SEW). I have taught in rural, northeastern Minnesota for the vast majority of my 15 year teaching tenure. Teaching in rural Minnesota can have obstacles from time-to-time, including limited staff development opportunities. I regularly attend meetings in the Twin Cities with GO4ST8 Physics. GO4ST8 Physics is group of Physics teachers that get together to talk about Physics curriculum, pedagogy, and topics four times per year. I found out about the AVS SEW application opportunity from one of the attendees late last year. She mentioned that she attended years ago and said that it was a wonderful workshop and that the financial obstacles were minimal. I read about the workshop on the AVS website and decided to apply. I was given notification that I was selected in September. I was elated and shocked that I was selected; me, the Physics and Chemistry teacher in little Moose Lake, MN. I was told that the majority of the financial obligations would be covered by the Minnesota chapter of AVS.

I arrived in San Jose, CA late morning on Sunday, October 18. The conference and workshop were well-organized. The first day we were given an introduction to the instructors. We were given opportunities to reproduce experiments provided with the AVS SEW curriculum. We also had a working lunch within curricula areas to brainstorm ideas of lessons that we could bring back to our classrooms in addition to the pre-written curriculum. In the afternoon, we attended a field trip to the Intel Museum in Santa Clara, CA. One of the highlights of the workshop was networking with other science instructors from all over the United States to see what they are doing differently, but also to take note of the similar things they do in their classrooms.



Photos from the Science Educator's Workshop at the AVS Symposium in San Jose, CA

On Tuesday morning, we continued through the AVS SEW curriculum. I found much, if not all, of the curriculum to be valuable to my courses' in Physics, Chemistry, and Physical Science. There are topics that I teach in my classes, but have only been able to show the students through videos due to aging equipment. I am also excited to integrate back into my curriculum the use of the vacuum pump. Prior to receiving the vacuum pump, my school had a Wegner 1410 vacuum pump from circa 1950. Last year I used it for the last time, as I felt it was no longer safe to use.

During lunch on Tuesday, the AVS president Mr. Ivan G. Petrov, awarded the attendees certificates of attendance. This was an honor as the workshop attendees were a small population of the conference attendees and he took time out his schedule to meet with us.

In the afternoon, we were given small-group tour of four different vendors on the convention hall floor. It was interesting to hear what they do, and how they use vacuum technology. We were then given time to talk to vendors around the convention hall floor. I will admit that this was the most intimidating part of the entire workshop. I have a background in Physics and Chemistry, but not to the extent that many of the individuals had that use this equipment. However, I was able to gain valuable information from many of the vendors to bring back to my school.

It was an enjoyable, unforgettable, and valuable experience. I do truly thank the Minnesota chapter of AVS for selecting me to attend the SEW this year.

HIGHLIGHTS OF AVS SYMPOSIUM 2015, By Ali Rafati

The MN-AVS Symposium took place on the 9th of September, 2015, sponsored in part by Medtronic, Seagate Technology and Physical Electronics. This year we had a fantastic program with a mix of academic and industrial speakers from institutions such as the University of Nottingham, the University of Minnesota and the National Physical Laboratory (NPL) of the UK (UK's NIST) and companies including 3M, Hutchinson Technology, Inc. and Seagate Technology.

Morgan Alexander from the University of Nottingham was the first speaker and gave a talk on "Biomaterials discovery using material microarrays: from polymer spots to devices via surface analysis." In this talk he described how blending a range of UV-curable acrylates in various combinations, exposing them to bacteria and then analyzing with time of flight secondary ion mass spectrometry (ToF-SIMS) was capable of identifying new acrylates that appear to resist bacterial adhesion. This allowed for scale up to a catheter and results shown suggest bacterial adhesion was dramatically reduced with this new material.



AVS MN Chapter Symposium , Sep 2015, left: Morgan Alexander, University of Nottingham , Right: Alex Shard, National Physical Laboratory

Alex Shard of NPL gave a talk on "Measuring organic shrubbery on surfaces and nanoparticles." Nanoparticle science is increasing in prevalence, PowerPoint chemistry is often presented by groups who work with nanoparticles that may be misleading; Alex suggested that using surface analysis is important to understand the modification of these surfaces. Analysis by X-ray photoelectron spectroscopy (XPS) and ToF-SIMS suggests films of organic materials at the surface of nanoparticles that can modify their behavior and add to the thickness of the overlayer are always present. Alex also presented a mathematical method to measure overlayer thickness from nanoparticles by XPS.

Fred LaPlant of 3M gave a talk on the quandary faced by industrial scientists and provided a historic perspective showing how across the decades papers from industrial sources have reduced in number from a high proportion of the total papers in the greater literature to the current situation where they are a small minority. The reason for this is attributed to changes in company policies and the lawyers employed to mitigate risk to companies. Fred emphatically supported all industrial scientists to do their best to publish in exterior journals going forward and not to be disheartened but to design experiments that would allow for publication.

Peter Ladwig from Hutchinson Technology, Inc. gave a fascinating talk about the "Miniaturization of electromechanical medical devices using semi-additive photolithographic fabrication technologies." First semi-additive photolithographic fabrication was defined and the need for these was highlighted. Much smaller technologies are being produced i.e. wearable technology and trends suggest this is the direction technology is going in. Smaller and fewer components are required and as such advanced methods for production are required. Semi-additive manufacturing allows for 2D and 3D structures to be "grown."



AVS MN Chapter Symposium, Sep 2015, left: Fred LaPlant, 3M, Right: Peter Ladwig, Hutchinson Technology Inc

Bharat Jalan of the University of Minnesota gave a talk on “Hybrid molecular beam epitaxy (MBE) for functional oxide thin films and heterostructures.” Bharat gave an entertaining talk on complex oxides (perovskites) for semiconductor applications. Controlling the stoichiometry using MBE was shown to be able to produce good coatings of the complex oxides presented.



AVS MN Chapter Symposium, Sep 2015, Left: Bharat Jalan, University of Minnesota, Right: Michael Kautzky, Seagate

Finally our after dinner speaker was Michael Kautzky from Seagate Technology. Michael gave a talk entitled “Heat-Assisted Magnetic Recording (HAMR): fundamentals, reliability, and the path to productization.” This was a fantastic talk about exciting new technologies for the improvement of hard disk storage size. First the industry was described with cost per GB of storage reducing over time and peoples storage requirement increasing over time, new technologies are required to meet with global demand. HAMR is the technology that allows for greater storage density however large changes have needed to be made in the read/write head that now includes a laser for localized heating of the disk. This talk brought the themes of the symposium to a head with parts of many of the prior talks brought together, as microelectronics and complex surfaces are all present in these products. Interesting insight into the problems and route to ‘productization’ gave a real world example of product development in industry.

Nine posters were presented with the grand prize of a \$1,000 travel stipend to next year’s AVS Symposium being awarded to Peng Xu for his presentation on “MBE growth, and the study of structure and electronic properties of NdTiO₃/SrTiO₃ interfaces.” This poster was well presented and formed the basis of the presentation by Bharat Jalan. Koustav Ganguly and Nancy Trejo won the runner up prizes of a year’s AVS membership.

Between these great talks the poster session and exhibitor hall was busy and full of conversation. I’d like to thank everyone who contributed to making this event the great success it was and we look forward to next year’s event.



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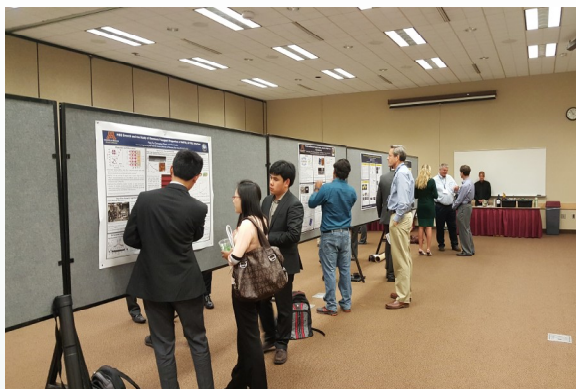
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POSTER AWARD WINNERS



AVS MN Chapter Symposium, Top Left: Poster session, Top Right: First Place, Peng Xu, Bottom Left, Second Place, Koustav Ganguly, Bottom Right: Third Place, Nancy Trejo

FIRST PLACE

The winning student received a travel stipend of \$1000 to the AVS International Symposium. The Second and Third place received one year AVS Membership

MBE growth, and the study of structure and electronic properties of $\text{NdTiO}_3/\text{SrTiO}_3$ interfaces

Peng Xu, Christopher Cheng and Bharat Jalan

Chemical Engineering and Materials Science, University of Minnesota

In this presentation, Peng and Chris presented a novel approach for creating high-density two-dimensional electron density at perovskite heterojunction using internal charge transfer for novel electronic devices such as high charge-gain power electronics. 2D carrier density much higher than $3 \times 10^{14} \text{ cm}^{-2}$ ($0.5 \text{ e}^-/\text{u.c.}/\text{interface}$ expected based on resolution of the polar discontinuity at perovskite oxide heterojunctions) was achieved via internal charge transfer using band-engineering approaches. Combining the state-of-the-art molecular beam epitaxy growth study with DFT modeling and experiments using x-ray photoelectron spectroscopy, scanning transmission electron microscopy, electron energy loss spectroscopy, energy dispersive x-ray spectroscopy and electronic transport measurements, they proved the origin of these carriers, dimensionality and transport mechanisms, and showed that electron and hole doping via band-engineered approaches may provide an exceptional route to revisit the phase diagrams of transition metal oxides in the “clean” doping limit.

Bio of Peng Xu: I am a Ph.D candidate in Materials Science and Engineering at the University of Minnesota. After receiving my bachelor's degree in Materials Science and Engineering from the University of Science and Technology, Beijing, I joined Prof. Bharat Jalan's group in Chemical Engineering and Materials Science department, working on growth of NdTiO_3 thin films using a hybrid Molecular Beam Epitaxy method. My research interest lies in interfacial effect on electronic and magnetic properties of $\text{NdTiO}_3/\text{SrTiO}_3$ heterostructures.

SECOND PLACE

Electronic Transport in $\text{BaSnO}_{3-\delta}$ Deposited *via* High Pressure Oxygen Sputtering

Koustav Ganguly, Abhinav Prakash, Jong Seok Jeong, K. Andre Mkhoyan,

C. Leighton, and Bharat Jalan

Chemical Engineering and Materials Science, University of Minnesota

In this work, the authors establish vacuum annealing as a facile route to create oxygen vacancies in BaSnO_3 films grown via high pressure oxygen sputtering technique. High-resolution x-ray diffraction confirms phase-pure, epitaxial BaSnO_3 films with (001) orientation on SrTiO_3 (001), MgO (001), and LaAlO_3 (001). The out-of-plane lattice parameter of films, obtained from wide angle x-ray diffraction (WAXRD), has been used as a sensitive probe for stoichiometry and strain relaxation. Thermal annealing under vacuum better than 10^{-7} Torr results in n-type doping of the material, with carrier concentration in excess of 10^{19} cm^{-3} and room temperature mobility of $50 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$. Temperature dependence of resistivity shows metallic behavior with a weak upturn at low temperature. Detailed temperature dependent magnetotransport measurements have been performed to understand the mobility limiting factors in $\text{BaSnO}_{3-\delta}$ films.

Bio of Koustav Ganguly: I graduated from Indian Institute of Technology Kharagpur in 2012 with a joint B.S. and M.S. degree in Metallurgical and Materials Engineering. After graduation, I came over to the University of Minnesota and joined Prof. Chris Leighton and Prof. Bharat Jalan's research groups. I aspire of becoming a researcher in the field of electronic and magnetic materials at a research facility someday.

THIRD PLACE

Improving Grain Growth in $\text{Cu}_2\text{ZnSnS}_4$ Thin Films

Nancy D. Trejo, Boris D. Chernomordik, and Eray S. Aydil

Chemical Engineering and Materials Science, University of Minnesota

In this study, Nancy and Boris demonstrate a facile method of incorporating Na into $\text{Cu}_2\text{ZnSnS}_2$ (CZTS) nanocrystal (NC) solar cells to improve CZTS grain sizes and to limit the growth of MoS_2 . They form CZTS films from colloidal dispersions of NCs cast onto Mo-coated soda lime glass (SLG) and annealed in a sulfur atmosphere. The CZTS phase is confirmed with x-ray diffraction, Raman spectroscopy, and energy dispersive x-ray spectroscopy. Na in SLG diffuses into CZTS to promote grain growth. Longer annealing times allow for larger grains but also encourage MoS_2 formation, which can block Na diffusion. They solve this problem by incorporating Na from the vapor phase during annealing. Scanning electron micrographs show an increase in CZTS grain size and thinner MoS_2 with Na addition, both conducive to improving solar cell performance.

Bio of Nancy Trejo: I grew up in Hidden Valley Lake, California and received a B.S. in chemical engineering from the University of California, Santa Barbara. I am currently a chemical engineering Ph.D. candidate at the University of Minnesota. I joined Prof. Eray Aydil's research group in 2012 to study the chemical synthesis and performance of CZTS solar cells. After I graduate, I plan to continue studying solar cells or other renewable energy technologies at a large company.

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For more information, please contact Jeff Zeske at Medtronic (Jeff.zeske@medtronic.com)

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