INTERSECTIONS
Materials Research & Science Policy
News and information from the MRS Government Affairs Committee
Advancing materials. Improving the quality of life.

SPRING 2013 NEWSLETTER

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Editor, INTERSECTIONS
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Welcome to our Spring 2013 Newsletter!

With Congress deliberating budgets for FY2014 under the self-imposed constraints of sequestration, there is great concern for the impact of budget cuts on the long-term support for science and technology. The mandated cuts that have gone into effect this year have already had serious consequences for the scientific community. The MRS Government Affairs Committee aims to understand the changing policy environment and its impact on materials research. This quarter the Committee continued to monitor changes affecting R&D policies, coordinated a new online letter-writing campaign in support of NIST, NSF, DOE Office of Science and DoD Basic Science funding and, separately, voiced our concern for the recently imposed federal employee travel restrictions. Kevin Whittlesey, our Congressional Science & Engineering Fellowship subcommittee chair, announced our selections for new MRS/OSA and MRS/TMS Congressional Fellows to begin work on Capitol Hill this coming fall. Tabbetha Dobbins, our Grassroots Chair, reports on three letters GAC created for members to mail to their representatives and the new GAC initiative to organize members in op-ed letter writing. Linda Olafsen describes our volunteers' activities on Capitol Hill during this spring's Congressional Visits Day. David Norton reports on the Government Agency Forum at the MRS Fall and Spring Meetings and the ways that GAC engages government agencies on issues of mutual interest. The *INTERSECTIONS* article on value-added materials science in this issue features yet another success story, highlighting how investments in materials science paid off in ways that the general public and especially our elected officials can relate to. MRS is working hard to make sure that the materials research community is being heard and that it has input in developing effective government policy for support of materials science. Here is the latest news.

A MESSAGE FROM OUR GOVERNMENT AFFAIRS COMMITTEE CHAIR

Nabil Bassim
Chair, Government Affairs Committee

Greetings from your Government Affairs Committee Chair! Things have certainly gotten interesting this spring! As of this writing, the "sequester" has been implemented, with major effects on the scientific R&D budget this year and upcoming years. This lack of funding will control the trajectory of scientific research funding in profound ways, unless some compromise can mitigate the damage in our community. Beyond budgetary issues, MRS is working on new issues in Open/Big Data, the Materials Genome Initiative, Helium availability, federal travel and the Reauthorization of the America COMPETES Act.

From the perspective of the Chair, I would like to commend the efforts of all MRS volunteers and staff on the Government Affairs Committee and the membership of MRS more broadly who have worked hard this quarter, whether it be in providing 2013 MRS Spring Meeting Government Agency programming, Materials Voice letters, Congressional Visits, selecting new Congressional Fellows or providing analysis of the 2014 Proposed Federal Budget for Materials R&D.

If you are interested in participating in the Government Affairs committee, you are most welcome. Please contact us at publicaffairs@mrs.org. We hope that you enjoy the rest of the *INTERSECTIONS* newsletter!

WHAT'S HAPPENING IN WASHINGTON

Ronald L. Kelley
MRS Washington Consultant

The Federal Government is finally operating on agreed upon budget levels for FY2013 after the impact of budget reductions and sequestration cuts, and at the very same time planning for FY2014 with a wide range of unresolved budget options for science. Unfortunately there is a new research baseline which has been established that is considerably lower than funding levels for FY2012, affecting new program starts, many grants and size of programs and

other aspects of the research infrastructure including federal employee travel restrictions.

MRS members can provide their opinions to policy makers and benefit our community, when they write their Members of Congress via MRS Materials Voice website. Our MRS Spring Congressional Visits Day in mid-March, which is reported in this issue, also gave voice to many of these same topics.

As proposed, the House of Representative budget for FY2014 is very different from the Senate budget proposal and will likely lead to opposing appropriations for science from the two chambers. The President's budget released on April 10 continues to recommend priority for the physical sciences for NSF, NIST, DOE Office of Science, and DOD basis research. The months of April, May, June and July will set the stage for all negotiations and conference decisions on budget reconciliation.

MRS has completed our analysis of the materials budget, within the Administration's FY2014 request, and that report from the Washington, D.C. office can be obtained from AAAS at their website.

The Materials Research Society is supportive of the reauthorization of America COMPETES legislation for many of the core science funding agencies. As the House Science and Space Committee develops their plans for this multi-year authorization bill, there have been many new issues raised that are challenging the science community's full support. We are emphasizing the importance of maintaining the peer review process, without political interference, and preserving the value of multiple research programs.

Congress has been moving in a timely manner on the approval of helium legislation, by passing H.R.527 in the House, and currently preparing for markup of the Senate helium bill, S.783. The helium end users coalition, which MRS participates in, has been actively supporting this legislation and we expect the bills to be in conference before October. One of our MRS Government Affairs Committee members, Carolyn Duran of Intel Corporation, provided testimony on the importance of helium reauthorization legislation to Senate Energy and Natural Resources Committee on May 7.

NOW IS THE TIME FOR YOUR OPINION TO BE HEARD

Tabbetha Dobbins
Chair, Grassroots Subcommittee

Dear MRS members—Although we we are approaching summer vacation period, our advocacy work supporting funding for basic research cannot break for vacation!

On May 22, 2013, we released a new MRS Public Affairs Alert containing three letters addressing: "Department of Defense Basic Science Funding", "Funding at NIST, NSF, DOE Office of Science and the DoD Basic Science" and "Federal Travel Restrictions". Please take two actions: (1) log in to www.mrs.org/materials-voice and send your letter to your representative and (2) share the link to our Public Affairs Alert page with your colleagues, friends and family members so they might do the same.

The Grassroots subcommittee's effort to organize members in letter writing is not limited to letters to your representatives in Washington, D.C. We are continuing our "All Things Op-Ed" initiative whereby we provide resources, training, and support to MRS members who wish to write an opinion letter to the editor or an op-ed letter. The last issue of *INTERSECTIONS* contained an article written by Theodore Besmann (of Oak Ridge National Laboratory) titled: "Influencing Policy: Writing a Commentary or Letter to the Editor." This month, we will have a web-ex presentation by Kevin Finneran, Editor-in-Chief of the quarterly science and technology policy journal, *Issues in Science and Technology,* on the topic of "Writing an Effective Letter to the Editor or Op-Ed Piece." Finneran's biography can be found here. If you have questions about the "All Things Op-Ed" initiative, please contact me.

As always, please remember to "follow" or "like" MRS using social media (Facebook, Twitter, etc.) and to post or re-post articles concerning automatic cuts to science funding and their impacts. In doing so, you will inform others, scientists and non-scientists alike, of these issues.

Enjoy summer vacation, but don't take a vacation from letting your voice be heard in support of basic science funding!

MRS CONGRESSIONAL SCIENCE & ENGINEERING FELLOWSHIP CORNER

Kevin Whittlesey
Chair, Congressional Fellow Subcommittee

Representatives of the Congressional Fellowship Subcommittee joined counterparts from our partner societies earlier this year to interview the finalists from a very competitive applicant pool for the 2013-2014 MRS Congressional Fellowships. I am pleased now to introduce you to our incoming fellows. Look for their full bios to be posted on the MRS website in the coming months. I look forward to officially welcoming the new fellows at the annual welcome breakfast with former fellows, scheduled for the morning of September 3rd, just before the beginning of the science policy fellowship orientation program coordinated by AAAS.

The 2013-2014 MRS/OSA Congressional Fellow will be Sydney Kaufmann. Sydney is completing her PhD in Chemical Physics at the University of Colorado at Boulder. Sydney's policy interests include renewable and traditional energy development and science, technology, education, and math (STEM) education. The 2013-2014 MRS/TMS Congressional Fellow will be Megan Brewster. Megan earned her PhD in Materials Science and Engineering from MIT in 2011 and has since been working at GE Global Research with the chemical and energy storage group. Some of you may have already worked with Megan on GAC, since she has been active with GAC's Grassroots Subcommittee. Megan's policy interests include energy, science diplomacy, sustainability, research funding, and shared facilities.

The Congressional Fellowship Subcommittee has been working with our partner societies over the last few years to update the application and selection process. Those updates have now been finalized and agreed to by all of the partner societies. The societies have all agreed that, in the interest of transparency, we should make information on the selection criteria available. When the application materials are posted for the 2014-2015 application cycle, selection criteria will be posted on the website of all of the partner societies.

Lastly, in other news, this year's Congressional Visits Day (CVD) included an experiment in collaboration between GAC subcommittees. The Congressional Fellowship subcommittee provided a one-page program summary that was included with the CVD leave behind packet, to inform offices visited during CVD about the program and how to request a science fellow if that expertise would be of interest. Those of us participating in CVD all received very positive responses from the Congressional office staff, which will hopefully help generate more placement office opportunities for Congressional Fellows. This seemed to be a very successful pilot experiment and a great example of a creative way to dovetail the efforts of GAC subcommittees. I will be looking for additional opportunities to engage our current and former Congressional Fellows.

SPRING 2013 CONGRESSIONAL VISITS DAY

Linda Olafsen
Chair, Congressional Visits Day Subcommittee

Twenty Materials Research Society volunteers visited Washington, D.C. on March 12-13, 2013 in coordination with the annual Science-Engineering-Technology Congressional Visits Day event. While MRS still conducted its own training dinner and arranged the schedules and visits for the volunteers, a number of participants attended the SET-CVD briefing session at AAAS that included panels discussing the budget and congressional perspectives. Some of the newest CVD participants found the information valuable while some experienced CVD attendees benefited from the information provided. A number of MRS members, including Al Hurd, Ron Kelley, Linda Olafsen and Kevin Whittlesey attended the reception Tuesday evening to honor Representative Mike Honda (CA), who was one of the representatives honored with the George E. Brown Jr. SET Leadership Award. Former MRS Congressional Fellow Eric Werwa is the Legislative Director in the office of Representative Honda.

Linda Olafsen (center) and Kevin Whittlesey (right) at awards reception at the Rayburn building (courtesy SETCVD website)

The timing of this year's CVD was a bit unusual. In an effort to be present on Capitol Hill during a more relevant time in the budget process, the dates for CVD had been moved from April to March with the intent of these visits having a greater impact. However, the Administration did not release its budget according to schedule, so participants arrived to advocate without the President's budget in hand. In fact, the House released its budget just before CVD participants arrived, and the Senate budget was released on March 13 during CVD visits. While the lack of "hard numbers" made it impossible to advocate for specific levels of funding, it allowed MRS volunteers to focus on the broader and more general message of sustained and predictable support for federal funding of scientific research.

This event involved a balance of CVD veterans with first-time participants. Not only did this provide experienced leadership for those new to the process of visiting Capitol Hill, but it also enabled MRS to visit members of Congress from states and districts with which we previously had little or no contact. Many of these visits were strategic in terms of meeting with chairs, ranking members, and other key members of Senate or House committees and subcommittees for appropriations or science. While these committee members are closest to authorizing and appropriating funds for the National Science Foundation, the Department of Energy Office of Science, the National Institute of Standards and Technology, and Department of Defense Basic Research visits were not limited to these members as CVD volunteers seek to broadly inform members of Congress—all of whom vote on these bills—of the impact of federal funding of scientific research on the US economy, national defense, and global competitiveness.

MRS volunteers formed nine teams (two or three members each) to visit members from 53 Congressional offices representing 17 states (Alabama, California, Florida, Georgia, Kentucky, Maryland, New Mexico, New York, Ohio, Oregon, Pennsylvania, South Dakota, Texas, Virginia, Wisconsin, West

Virginia, and Wyoming). These visits also represented offices on both sides of the aisle, and volunteers had healthy discussions not only with those already known to be supportive of strong federal funding of scientific research, but also with offices that are perceived to be less friendly or supportive of such funding. While discussions were more pointed in some offices than others, CVD participants indicated that there was general bipartisan support and recognition of the value of federal research funding, though the details of how that will be accomplished were and remain to be the subject of continued discussion and debate. There was some immediate follow up with several offices, and MRS continues to be a resource for many of these offices for science funding as well as other issues important to the materials science community (helium, STEM education, diversity, etc.).

University of Wyoming's Jinke Tang with Wyoming Senators John Barrasso (left) and Michael Enzi (right).

The CVD Subcommittee is most grateful to Ron Kelley for his expert guidance and leadership as we arrange these visits and navigate Capitol Hill. Thanks to Jocelyn Goldblatt for successfully arranging our schedules on her first experience coordinating a CVD event, to Todd Osman at Headquarters and Nabil Bassim from the Government Affairs Committee for their continued support of our advocacy efforts, and to Donna Gillespie for helping us with all the vital details and keeping us moving forward. A Fall CVD event involving the Presidential Line and Board of Directors of MRS currently is being planned for September 19, with Agency visits to follow on September 20.

CONNECTING MRS INTERESTS TO US GOVERNMENT AGENCIES

David P. Norton
Vice-Chair, Government Agency Subcommittee

Within the materials community, the policies and actions of federal governments can have significant impact on how science is performed, supported, and regulated. The MRS Government Affairs Committee serves as an advocate and source of information relative to governmental science and technology policy in materials-related areas, interacting with national and international government officials on matters of science and technology policy. The committee serves as a resource for information relevant to the materials community, stimulates technical discussion and facilitates the exchange of information from the scientific community with policy makers and the general public.

Given that a sizable fraction of the MRS community are located in the US and thus significantly affected by US federal government policy and funding activity, the MRS Government Agency Subcommittee, chaired by Joshua Caldwell of the US Naval Research Laboratory, seeks to directly engage federal agencies on relevant issues. Each month, this group solicits invited articles from the agencies for the Materials360 e-newsletter. Each year, it plans and hosts an annual Government Agency Summit, during which agency leaders meet with the leadership from materials-related societies to discuss topics of mutual interest.

Perhaps the most visible activity of this subcommittee by the MRS membership is the Government Agency Forum that is held as part of the MRS Spring and Fall Meetings. It consists of multiple talks given by agency representatives focused on funding opportunities in the materials science and technology research areas. While these talks have typically been held during Tuesday and Thursday evenings, this past April, the Government Agency Forum was, for the first time, held as a half-day morning session, consisting of four talks presented by three speakers.

The first speaker was James Warren, Technical Program Director of Materials Genomics, Materials Measurement Laboratory, NIST. Warren provided an overview of the current status of the Materials Genome Initiative (MGI), and the multi-agency efforts to address some of challenges in creating the materials innovation infrastructure that lies at the heart of the MGI. NIST is working with partners in industry, academia and government to develop the tools, standards and techniques needed to enable materials data exchange and the means to ensure the quality of materials data and models needed to foster widespread adoption of new materials development approaches such as of "materials by design". His talk and subsequent discussion also ventured into the many aspects of open access and how that would factor into the materials data evolution.

Linda Horton, Director of the Materials Sciences and Engineering Division within the Office of Basic Energy Sciences in the US Department of Energy spoke on two topics. First, she provided an overview of the materials research opportunities within the Office of Basic Energy Sciences. This Office supports fundamental research and manages several national user facilities relevant to the materials science community. Topics discussed ranged from predictive theory and modeling, to mesoscale science, and the DOE-supported Energy Innovation Hubs. Horton described in detail the

process of application submission and highlighted on-line resources for principal investigators. Her second talk focused on the Energy Frontier Research Centers (EFRCs) that were established in 2009 by DOE's Office of Basic Energy Sciences. Her talk focused specifically on the various research opportunities, the operations of the EFRCs, their management practices, impact, and outreach activities.

Elaine Ulrich, Program Manager within the Solar Energy Technologies Office of the US Department of Energy, described the DOE SunShot Initiative. This is a collaborative effort to make solar energy cost-competitive with other forms of energy by the end of the decade, targeting an installed price for utility-scale photovoltaic solar systems at $1/W. SunShot supports a wide variety of research related to materials science. Her presentation also included discussion of future interests within the program.

After the talks, the agency speakers were made available for individual questions and discussion. Due to federal government travel restrictions, many of the other speakers scheduled for the Forum were unable to attend. However, despite this difficulty, the Forum was well attended and successful at providing MRS Meeting attendees the opportunity to hear directly from agency representatives and to engage them one-on-one to explore how various programs might benefit their research efforts.

A VALUE-ADDED MATERIALS RESEARCH STORY

Compound semiconductors for engine ignition timing in automobiles?

Joseph Heremans
Departments of Mechanical & Aerospace Engineering and Physics, Ohio State University

GaAs and similar compounds have well-known uses in high-speed electronics and in optoelectronic devices. What may be more surprising is that they have had a decade-long career in automotive ignition. This was just another example of how developments in materials research have paid off in offering surprising solutions to otherwise seemingly impossible problems. And, while materials are often considered as commodities, they are really technology enablers: a small improvement in a material can lead to a great simplification in a complete system, and, if all goes well, to cost savings.

This example is two decades old, when OBD-II (On-Board Diagnostics, version II) were imposed as a regulation to the automotive industry. OBD-II required that the vehicle be able to identify when a cylinder misfired, for whatever reason. Automotive engine manufacturers investigated a number of obvious possibilities, like engine pressure sensors. They came to the conclusion that the most effective solution would be to develop an absolute position sensor that was accurate enough to sense the small accelerations that accompany the power stroke in each cylinder. This approach makes it possible to not only offer OBD-II misfire detection, but also provide the timing signal for fuel injection and spark ignition, killing two birds with one stone. Again, the obvious solutions involved encoders and optical detection, but all of these wore out or soiled with grime and oil and dirt. Magnetic position sensors, which involved a toothed wheel machined into the crankshaft or bolted onto it, and a magnetic field sensor mounted on a permanent magnet, could operate directly in engine oil and never wear out.

This was the time when Giant Magneto-Resistance (GMR) was invented. Magnetic pick-up coils, Hall Effect, and GMR sensors were studied for crankshaft speed and position sensors at the General Motors Research Laboratories (also GMR) in Warren, MI, in conjunction with GM Powertrain. Pick-up coils came into use with other manufacturers. GM powertrain chose to use magnetostatic sensors, such as magnetoresistors or Hall sensors, because they provide piston position and engine timing information regardless of the crankshaft speed, and thus can provide spark timing from standstill: engines with these sensors start much faster, something every customer appreciates. Now came the challenge for materials research. GMR sensors detect extremely small magnetic fields, but in an engine there are many stray fields (sparks, coils, starter motors...) that lead them astray –a much better design field is around 0.1 Tesla. Hall sensors in the 1980's were made either from InAs, or as Si integrated circuits, which were not very sensitive. InAs is a narrow-gap semiconductor, so at first it appeared that the high temperature requirements in an engine (-40 to 200 ^{o}C) would be prohibitive; but this was not so. Research at GMR then concluded that even InSb, which has a narrower gap yet, could be used provided one folded the Hall voltage into the resistance by using geometry akin to that of the Corbino effect. And so the geometrical InSb-MR was born in the late 1980's, covered by numerous patents by J.P. Heremans, T. S. Schroeder and D.L. Partin, and put into production in the early 1990's. It is rather amusing to notice that a publication on geometrical magnetoresistance effects in InSb, *by* S.A. Solin and several co-authors appeared in *Science* roughly a decade after the geometrical InSb-MR went into production at GM.

These geometrical MRs were made from InSb films grown epitaxially on GaAs, in the lab by MBE at first, in production by MOCVD. The first units were produced by Spectrolab, then a division of Hughes Corp. which was a subsidiary of GM, and

went into hundreds of thousands of small truck engines every year. The cost of a III-V device is always an issue: further research resulted in the development of much smaller die, and a change in supplier cut the cost further and enabled their use in most of GM's V6 and V8 engines for over a decade, reaching production volumes of many millions.

As with all technologies, there came a point in time when a cheaper technology replaces it. Here, integrated Si Hall sensor caught up with the performance of the III-V compound die, which required a decoding circuit anyway. After roughly 2005 the new engine timing system designs were based on integrated Si Hall sensors rather than InSb magnetoresistors. Nevertheless, this exemplifies how a very small 1x2mm die of a relatively exotic material can solve a mechanical problem that at first looked like an insurmountable government-dictated mandate, and do it profitably. In recognition of his work, Jos Heremans was elected this year to the National Academy of Engineering.

FEEDBACK

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