

# FIAP Newsletter

Forum for Industrial and Applied Physics ▪ [www.aps.org/units/fiap](http://www.aps.org/units/fiap)

Summer 2007

Edited by Alexander Bratkovski

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## Important Deadlines and Dates

*FIAP Invited Symposium nominations	Friday, September 15, 2007
*Vote: FIAP Officers and Executive Committee	Friday, September 15, 2007
*New Orleans Contributed Abstracts	Tuesday, November 27, 2007
*APS Fellow Nominations	Friday, May 1, 2008
New Orleans APS Meeting	March 10-14, 2008

*\*See below for more details.*

## In this Issue:

[A Note from the FIAP Chair](#)

[Invited Symposium Nominations](#)

[Call for Invited Speaker Suggestions](#)

[The 2008 March Meeting](#)

[APS Fellow Nominations](#)

[Join FIAP!](#)

**[Special Article: Report of the APS Task Force for Industrial Physicists \(August 26, 2006\)](#)**

## A Note from the FIAP Chair

The APS recognizes that industrial physics has moved away from the old large corporate research labs (e.g. Bell Labs, IBM Research, Xerox PARC, etc) to decentralized research and development efforts in smaller and medium sized companies. The APS is now keenly interested in how it can better meet the needs of its constituents in such companies and organized a task force to study the situation of modern industrial physicists and recommend ways that APS could become more relevant to them. The task force's report can be found as a *Special Article* at the end this Newsletter.

FIAP will be holding elections for 2008 Executive Committee positions this fall. Up for election will be two Members-at-large, one Secretary-treasurer, one Councilor, and one Vice-chair. Each position serves a three year term.

- The Members-at-large are representatives of the FIAP community and serve on various FIAP committees.
- The Secretary-treasurer keeps track of FIAP's finances and takes the Executive Committee meeting minutes.
- The Councilor serves as FIAP's representative to the APS Council.
- The Vice-chair's main duty is to head the FIAP program organization for the 2009 APS March Meeting and will serve as Chair-elect in 2009, then Chair in 2010.

The Executive Committee meets once per year during the APS March Meeting and conducts most of its business during the year by email and phone. In addition, the Councilor normally attends meetings of the APS Council.

If you are interested in being nominated to run for any of these positions, or know someone who might want to be nominated, please email me at [mlee1@sandia.gov](mailto:mlee1@sandia.gov).

Mark Lee, August 2007

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## Invited Symposium Nominations

The deadline for Invited Symposium nominations is Friday, September 15. In order to nominate an Invited Symposium for the March Meeting go to:

[http://meetings.aps.org/aps\\_invited/Invited/LoginForm.cfm?MT=MAR08](http://meetings.aps.org/aps_invited/Invited/LoginForm.cfm?MT=MAR08)

The entire Executive Committee selects invited talks only from those proposals nominated by FIAP members. It cannot substitute speakers of its own choosing.

Copy your suggestions to Mark Lee ([mlee1@sandia.gov](mailto:mlee1@sandia.gov)) and A.B. ([alex.bratkovski@hp.com](mailto:alex.bratkovski@hp.com)).

### ***Suggestions for Creating a Successful Proposal***

1. **Propose a Symposium on a timely idea with 5 strong talks.** In general, the FIAP favors symposia, and uses single speakers sparingly.
2. **Choose a good Symposium Title and provide a clear Symposium Justification.** This will give the selection committee an overview of the Symposium.

3. **Choose titles of individual talks carefully.**
  4. **Provide an informative abstract for each talk.** This will underpin the idea of Symposium and give the selection committee a better idea of what the session will accomplish. The speaker can change them later.
  5. **Provide recent references published in refereed journals.** These are helpful to the Committee to make sure work is current.
  6. **Include an alternate speaker** in the abstract to provide an excellent substitute if the first choice is unavailable.
  7. **Use the correct sorting category** (given below) to ensure that the correct subcommittee examines proposal. ***Multiple submissions of a proposal are ineffective and counterproductive.***
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## Call for Invited Speaker Suggestions

With this issue of the Newsletter, the Forum for Industrial and Applied Physics announces the program of FIAP Focus Topics for the 2008 APS March Meeting (New Orleans, LA, March 10-14, 2008). A Focus Topic generally consists of a series of sessions, each of which is typically seeded with one invited talk, the remainder of the session being composed of contributed presentations. FIAP members are encouraged to make suggestions for invited speakers for Focus Topics. The deadline for submitting suggestions is August 31, 2007. Suggestions can be made by emailing the suggestion directly to the appropriate focus topic organizers who are listed after the Focus Topic descriptive paragraphs. Also, please send a copy to A.B. ([alex.bratkovski@hp.com](mailto:alex.bratkovski@hp.com)), the main FIAP organizer of Focus Topics for Mar08 APS meeting.

Your suggestions should provide the following information:

- The nominator's name, affiliation, phone number and e-mail address.
- The suggested speaker's name, affiliation, address, phone number, fax, and e-mail.
- The title of the suggested talk.
- A brief justification of the nomination (880 character limit, including spaces).

The contents of this Newsletter will be available electronically on the FIAP website at <http://www.aps.org/units/fiap>. In case of any need for corrections or updates, these will be posted at this location, too.

### **16.12.1 Emerging Research Devices & Materials for the Microelectronics Industry (FIAP)**

Scaling of CMOS devices following Moore's law has led to a significant reduction of the size and cost of highly integrated microelectronic devices. In past generations, scaling was often limited to a size reduction of CMOS transistors without much innovation in the device architecture or the materials used, but this is changing. At the 90 nm node, silicon-germanium source-drain stressors were introduced and high-k metal-gate stacks were announced for 45 nm devices (expected in mass production at the time of the conference). Additional innovations will be needed at the 32nm and 22nm nodes, such as silicon carbon alloy stressors, rare earth silicide contacts, carbon nanotube interconnects, and III/V materials (e.g., InGaAs) or graphene in the transistor channel. Even with these innovations and new materials, CMOS is already reaching power density limits which are fundamental to a charge-transfer based switch, and future generations beyond 22nm may need entirely new device architectures. These may include devices which use alternative, non-charge based state variables, such as carrier spin, molecular conformation, or phase state, for logic, or devices and architectures that employ novel means to mitigate power, such as non-equilibrium or adiabatic systems. All of these innovations (see <http://www.itrs.net/>) are aimed at finding better power / performance tradeoffs that allow further device scaling in some form, to enable us to continue the historical decreasing cost per function, which has driven the computing industry and IT economy for the past 40 years. Researchers from industry, government, and

<http://units.aps.org/units/fiap/newsletters/index.cfm>

academia are invited to submit abstracts in these areas. These sessions will provide a stimulating dialogue between these three communities and cover both practical aspects and concepts on the frontier of technology. Submission of experimental, theoretical, materials and device physics, and integration papers is encouraged.

**Organizers:**

Stefan Zollner, Freescale Semiconductor, Inc, Hopewell Junction, NY 12533;

Email: [Stefan.Zollner@freescale.com](mailto:Stefan.Zollner@freescale.com) ; Phone: (845) 892-1839

Jeff Welsler, IBM Almaden Research Center, San Jose, CA 95120;

Email: [welsler@us.ibm.com](mailto:welsler@us.ibm.com) ; Phone: (408) 927-1017

**16.12.2 Negative Index Materials: Concepts to Applications (FIAP)**

Complex meta-materials with unusual electromagnetic properties, such as negative dielectric permittivity, magnetic permeability, and negative refractive index, have recently attracted significant interest due to their exotic behavior in several regions of the electromagnetic spectrum. The field now attracts significant attention due to a wide array of applications for such materials: super- and hyper-lenses capable of sub-wavelength resolution, sub-wavelength imaging and lithography, miniaturization of antennas, low-aberration lenses, devices capable of concentrating energy in very small volumes, and many others. The early work in the microwave range has been extended to negative index materials in the THz through optical, where many of the original concepts (such as super-lensing) either have been, or in the process of being demonstrated. These focus sessions will highlight recent advances in the field of novel meta-materials and their applications. Papers are solicited in all areas of design, demonstration, characterization, and simulation of negative index/negative permittivity/negative permeability materials. This includes novel concepts for extending the spectral range of such materials, new device concepts, industrial and scientific applications. Also solicited are papers dealing with the nonlinear properties of negative index materials, their combination with gain media, etc

**Organizers:**

Shih-Yuan (SY) Wang  
Hewlett-Packard Laboratories  
Quantum Science Research  
MS 1123  
1501 Page Mill Road  
Palo Alto, CA 94304  
office: 650 857 3111  
email: [sywang@hp.com](mailto:sywang@hp.com)

Igor Smolyaninov  
ECE, U Maryland  
E-mail: [smoly@umd.edu](mailto:smoly@umd.edu)  
Phone: (301)405-3255

**16.12.3 Negative Differential Resistance (FIAP)**

Molecular-scale devices have attracted much interest not only as a promise for the continuing miniaturization of electronics but also for the thrust this field has experienced from the National Nanotechnology Initiative (NNI). In two-terminal devices, the phenomenon of negative differential resistance (NDR) has received particular attention due to its promise for exhibiting bistable electrical characteristics and thus being suitable for implementing memory and switching functions, and also because several of the phenomena observed in molecular assemblies and

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metal-insulator-metal (MIM) sandwich devices with very thin self-assembled dielectric layers are not yet fundamentally understood despite a range of theoretical models that have been proposed for their explanation. This session solicits papers on all aspects of the characteristics of nano-scale devices based on molecular assemblies including theory, modeling, materials, preparation, and experimental techniques.

**Organizers:**

Richard Kiehl  
Electrical and Computer Engineering  
University of Minnesota  
200 Union St. SE  
Minneapolis, MN 55455  
Phone: 612-625-8073  
Fax: 612-625-4583  
[kiehl@ece.umn.edu](mailto:kiehl@ece.umn.edu)

**16.12.4 Physics of Thermoelectric Materials and Phenomena (FIAP/DMP)**

About 90 percent of the world's power (approximately 10 TW) is generated by heat engines that convert heat to mechanical motion, which can then be converted to electricity when necessary. Such heat engines typically operate at 30-40 percent efficiency, such that ~ 15 TW of heat is lost to the environment. If even a fraction of this low-grade thermal waste can be converted to electricity in a cost-effective manner, the potential impact on energy could be enormous, amounting to massive savings of fuel and reductions in carbon dioxide emissions. Thermoelectric energy converters can directly convert low-grade heat to electricity using semiconducting materials via the Peltier effect. The performance depends on the thermoelectric figure of merit (ZT) of a material, which is defined as  $ZT = S^2T/rk$  where S, r, k, and T are the Seebeck coefficient, electrical resistivity, thermal conductivity and absolute temperature, respectively. To be competitive compared to current engines and refrigerators (efficiency 30-40 percent of Carnot limit), one must develop materials with  $ZT > 3$ . Yet, over the last 50 years, the ZT of materials has increased only marginally, from about 0.6 to 1, resulting in performance less than 10 percent of Carnot limit! While there is no fundamental upper limit to ZT, progress has been extremely hard to come by, mainly due to the coupling between S, r, and k – changing one alters the others. It has been shown recently that nanostructuring allows one to either use quantum confinement of carriers or spectrally-dependent scattering of phonons to manipulate S, r, and k in ways that can increase ZT beyond the bulk values. The underlying reasons for this increase are, however, not yet fully understood. The goal of this session is to bring together scientists and engineers focused on quantum and classical transport and coupling of charge and heat in thermoelectric materials in order to increase ZT.

**Organizers:**

A. Majumdar,  
Univ. of California-Berkeley  
[majumdar@berkeley.edu](mailto:majumdar@berkeley.edu)

Ali Shakouri  
Electrical Engineering Department  
UC-Santa Cruz  
1156 High St, Santa Cruz, CA 95064-1077  
phone: (831) 459-3821  
fax: (831) 459- 4829

<http://units.aps.org/units/fiap/newsletters/index.cfm>

[ali@soe.ucsc.edu](mailto:ali@soe.ucsc.edu)

Terry Tritt  
Physics & Astronomy Department, Clemson Univ.  
118 Kinard Laboratory  
Clemson, SC 29634  
Phone: (864)656-7869  
Fax: 864-656-0805  
[ttritt@clemson.edu](mailto:ttritt@clemson.edu)

### **16.12.5 Hydrogen Storage; Materials, Measurements & Modeling (FIAP/DMP)**

Developing safe and reliable hydrogen storage technologies that meet performance and cost requirements is critical to the realization of the future hydrogen economy. Method to store hydrogen at low pressures and near room temperature are inherently more efficient than high-pressure or liquid storage technologies in principle. The challenge is to develop materials that have high gravimetric and volumetric hydrogen densities at moderate temperature and pressure conditions. The current focus on materials-based hydrogen storage includes adsorption in high surface area adsorbents such as metal organic frameworks and various carbon-based materials, absorption in complex metal hydrides, chemical hydrogen storage in chemical hydrides such as light metal borohydrides, and other, more novel approaches.

Many challenges still exist in achieving acceptable densities, kinetics, and reversibility, despite substantial progress in developing new hydrogen storage materials. This focus topic will bring researchers together to discuss current developments in novel hydrogen storage materials, accurate measurement techniques, and advances in modeling and theory.

Contributions are solicited in which include:

- Novel concepts and materials,
- New adsorbents such as metal-organic frameworks and metal-carbon complexes, B-C-N, aerogels, and polymer materials
- Optimizing hydrogen storage materials by doping, scaffolding, and alloying
- Novel synthesis methods of hydrogen storage materials
- Nanoscale phenomena and its effect on the thermodynamics and kinetics
- Advanced characterization and measurement techniques
- Theory and Modeling
- Atomistic understanding of hydrogen-metal bonding and hydride stability
- Fundamental thermodynamic and kinetic issues
- Catalyst mechanism and effects
- High-throughput/combinatorial approaches in hydride and catalyst discovery
- Hydrogen bulk and surface diffusion and dynamics

#### **Organizers:**

Hui Wu  
NIST Center for Neutron Research  
Materials Science and Engineering Laboratory  
Bldg.235, Mail Stop 8562  
Phone: 301-975-2387  
FAX: 301-921-9847  
[Hui.wu@nist.gov](mailto:Hui.wu@nist.gov)

Karl Johnson  
Univ. of Pittsburgh  
[karlj@pitt.edu](mailto:karlj@pitt.edu)

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College Park, MD 20740-3844

### **16.12.6 Materials & Application for Solar Energy (DMP/FIAP)**

Research on suitable absorber materials for efficient solar energy conversion and their effective application to photovoltaic devices, constitutes a key element in the reduction of the cost of solar energy production to competitive prices. This is especially true as the balance of systems cost drop with scale-up. Nanostructured architectures which efficiently absorb the full solar spectrum offer the potential to increase conversion efficiencies to nearly the thermodynamic limit. In addition, nanocomposite materials with simultaneous high electrical conductivity and low thermal conductivity offer great promise for significant enhancement in thermophotovoltaic conversion efficiency. This session will cover the latest advances in this area including topics such as: advances in high efficiency solar cell devices (multi-junction solar cells, crystalline silicon, etc.) and the development of low cost large area devices (thin films, organics, dyes, etc.). In addition to commercial or near-commercial approaches, the session will cover relevant novel concepts including (nanostructures, multiple carrier generation, intermediate band solar cells, etc.). We anticipate that the topic will bring together theoreticians and experimentalists from disciplines including physics, chemistry, chemical engineering, materials science, and electrical engineering, in order to address both fundamentals and device applications. Possible areas include the design and processing of materials to enable enhanced performance photovoltaics and thermophotovoltaics.

#### **Organizers:**

D. Ginley

National Renewable Energy Labs

[david\\_ginley@nrel.gov](mailto:david_ginley@nrel.gov)

Victor Klimov

C-PCS, MS-J567, Chemistry Divi, Los Alamos National Laboratory, Los Alamos, NM 87545

Phone: (505) 665-8284

Fax: (505) 667-0440

[klimov@lanl.gov](mailto:klimov@lanl.gov)

Antonio Marti

Instituto de Energía Solar - ETSIT

Universidad Politécnica de Madrid (IES-UPM)

Ciudad Universitaria sn

28040 Madrid, Spain - EU

Phone: +34 915495700 Ext 294

Fax: +34 915446341

[amarti@etsit.upm.es](mailto:amarti@etsit.upm.es)

### **16.12.13 Artificial Neurons (FIAP)**

New and rapidly expanding industries developing around biomorphic robotics and clinical neuro-engineering have established a tremendous demand for advancements in the technologies of autonomous artificial neural network devices, real-time analysis of brain activity, and of interfaces between the devices and brain tissue. A new field of physics, neurophysics, is emerging to answer these demands. A powerful language of nonlinear dynamics is used to describe the behavior of neuronal networks and the biomechanics of the body. One can formulate realistic models of the neural genesis of animal or human behavior to explore

<http://units.aps.org/units/fiap/newsletters/index.cfm>

unanswered questions of neuroethology and psychology in a new dimension. The session will bring together the most recent and exciting theoretical and experimental developments in neurophysics including new functional neuroimaging technology. The abstracts are solicited covering all areas of neurophysics including but not limited to functional neuroimaging techniques, autonomous neuronal networks, their interactions with the brain, software tools to generate and analyze models on a system level with detailed and accurate representations of the neuronal networks, testing of these approaches through real time hybrid systems comprised of living and artificial parts of human or animal body.

Presentations are invited addressing the following topics:

1. Autonomous neural network devices
2. Analysis of neuronal dynamics
3. Device-to-neuron interface
4. Medical feedback stimulation treatments of dynamical diseases (e.g., epilepsy, Sudden Infant Death Syndrome, and Parkinson's Disease)
5. Frontiers of functional neuroimaging technology
6. Software environments for physically realistic modeling on the system level

**Organizers:**

A. G. Unil Perera  
Georgia State University  
Phone 404 -413-6037  
[uperera@gsu.edu](mailto:uperera@gsu.edu),

Gennady Cymbalauk  
Georgia State University  
[gcym@phy-astr.gsu.edu](mailto:gcym@phy-astr.gsu.edu)

**16.12.17 High-throughput Approaches to Polymer Physics and Materials Science (DPOLY/FIAP) (same as 04.14.14)**

There has been significant interest in the application of combinatorial and high-throughput experimental approaches to accelerate research on polymers and other materials systems. Recent successful applications of such methods to research polymer films and coatings, formulated fluids, complex materials, organic electronics, biomaterials and nanostructured materials has highlighted the advantages of using such approaches. This joint DPOLY/FIAP sponsored topic will focus on the applications of such methods in Polymer Physics and Materials Science.

**Organizers:**

Ramanan Krishnamoorti  
Department of Chemical & Biomolecular Engineering  
University of Houston  
Houston, TX 77204-4004  
(713) 743-4312  
[ramanan@uh.edu](mailto:ramanan@uh.edu)

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## The 2008 March Meeting

The March meeting will be held in New Orleans , LA , March 10-14, 2008. This year, FIAP will organize 8 (compare to 34 by DCMP) of the 94 total invited symposia. If last year is any guide, there will be roughly 40 parallel sessions and the Bulletin (which most participants will only have in electronic form) will run over 1000 pages.

### **Contributed Abstract Submission**

The deadline for receipt of abstracts is Tuesday, November 27, 2007 at 5:00 p.m. EST.

Complete abstract submission instructions can be found at:

<http://www.aps.org/meetings/abstract/index.cfm>

Note that the Sorting Categories for abstracts (which is much more detailed than the one for invited symposia) can be found at:

<http://www.aps.org/meetings/march/categories.cfm>

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## APS Fellow Nominations

FIAP members are encouraged to make nominations for Fellowship in the APS. The Forum is able to elect each year one-half of one percent of the current membership. Nominations may be made at any time, but only those received by the deadline, May 1, will be considered for action in that year. Nomination instructions and advice for preparing a strong nomination are available at: <http://www.aps.org/programs/honors/fellowships/nominations.cfm>

Unsuccessful nominees are automatically reconsidered in the second year after nomination. Updated information from sponsors is recommended.

In March, the FIAP Fellowship Committee, made up of the Members-at- Large of the FIAP Executive Committee, reviews the nominations referred to the FIAP by the APS and makes recommendations to the APS Fellowship Committee.

### ***Tips for Successful Nominations***

The selection process is very competitive; when preparing nominations, sponsors should ensure that the achievements of their candidate are genuinely reflected by the material submitted. In general, the Fellowship Committee looks for sustained contributions to the field and successful nominees generally have over 10 years of professional experience beyond the Ph.D. Choose the (8) representative publications and the (10) other contributions with care. The supporting letters, which evaluate the candidate's work and discuss which of the candidate's achievements are "exceptional," aid the committee considerably.

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## Join FIAP!

Most, if not all, persons reading this are already FIAP members. So why put a call to join the division in the newsletter? Well, we hope that all current members continue as members in the upcoming year, especially since joining the FIAP is free!

What do you get for membership? Both the number of invited symposia that we can organize and the number of Fellows that we can recommend are tied directly to the division membership. Any increase in these numbers benefits the entire community.

# REPORT OF THE APS TASK FORCE FOR INDUSTRIAL PHYSICISTS

(final 08/26/06)

## 1. Introduction

The world has changed profoundly during the past 20 years (1). The Cold War has morphed into a War on Terror. A set of loosely coupled national economies has evolved into a highly interconnected and tightly coupled global economy based on a worldwide digital information network—the Internet (1,2). The creation of economic value from research knowledge has moved from the province of vertically integrated firms to loose global consortia (2,3). Research projects and their funding have gone global, with contributors from all over the world working together via the Internet (1,2). Trained technical manpower has become globally available and plentiful, as has the capital for commercially oriented R&D projects (2).

These changes have exerted a powerful influence on physics and physicists. An increasing percentage of physics PhDs are employed by industry: Up from 36% in the 1950s to 56% in the 1990s (4). In the global economy, the value of R&D, including physics R&D, is increasingly measured in terms of the economic value resulting from that R&D (1-3, 5). Moreover, this value is no longer being created primarily in large firms that sponsor central R&D organizations that perform basic research, like Bell Labs, GE, IBM, Dupont and Xerox in the past. Rather new models of creating value of R&D are being pioneered in which loosely-coupled, globally distributed organizations connected via the Internet constitute the new product development pipelines (2,3). In this new world industrial physicists no longer do basic research in the physical science in analogy with their academic cousins. Rather they perform applied research directly related to product development in a fashion that has historically been more associated with engineering than with science (6,7). Thus, their activities increasingly migrate away from the topics of interest to the American Physical Society (APS) to those sponsored by more applied oriented Physics Societies like OSA and AVS or sponsored by engineering societies (like the IEEE) and materials science oriented societies (like MRS or ACS).

Because of these changes, the role of industrial physicists in the APS has been declining. The percentage of APS members employed by industry has been dropping to its current value of about 20% (8). Industrial APS members rarely either publish in APS journals or attend its meetings (9). They receive a negligible share of APS prizes and awards, including Fellowship (8). Very few are active in APS governance (8). Approximately 70% belong to some other professional society in addition to APS (9). Most are connected to APS primarily via their use of *Physics Today* and *APS News* (9). Thus, at a time when the importance of physics to the nation is increasingly felt via its contributions to economic growth and prosperity, the role of the physicists who make these contributions in the APS has declined to the point of being almost invisible in the major APS activities.

Given this increasing gap between the need for a prominent physics profile in the global economy and the declining role of industrial physicists in the APS, the APS Executive Board commissioned a Task Force for Industrial Physicists to assess the competitive situation of APS activities for industrial physicists and to make recommendations of how it can better serve this segment of its membership. The charge to the task force is presented in appendix A. The membership of the task force consisted of eight industrial physicists from a variety of firms. The roster is given in Appendix B. Several initial members dropped out during the study: A reminder of the low priority given APS activities by industrial physicists who are struggling daily just to perform their jobs in [American Physical Society • Forum for Industrial and Applied Physics • One Physics Ellipse • College Park, MD 20740-3844](#)

difficult environments. The task force held seven teleconferences commencing on January 26, 2006 and concluding on August 15, 2006. It performed an assessment of a partnership proposal by Fortnight Solutions for a web-based technical solutions service. It conducted an extensive survey of the competitive services and offerings of other scientific and technical societies serving industrial physicists. These results are reported in Appendix C. It prepared a questionnaire of the industrial members of APS and assisted in analyzing the results, which are reported in reference 9. Finally, based on the results of its studies, it proposed and refined recommendations pertaining to each item in the statement of task.

This document is the report of the Task Force for Industrial Physicists. In Section 2 the task force identifies the market segments that together comprise industrial physicists and gives a profile of those industrial physicists who are members of APS. Section 3 of this report addresses the first item in the charge to the task force: Improved Web services. Section 4 addresses the second item: Comparison of APS services to industrial physicists with those of other technical societies serving this audience. Because other societies serve important needs of this audience that APS does not, collaboration of APS with other societies to create enhanced relevant offerings and services is an essential step for APS to enhance its attractiveness to industrial physicists. Section 5 is devoted to the articulation of three specific, actionable recommendations to achieve this objective, in response to the third and final item in the statement of task.

## **2. Who are “Industrial Physicists” and What do They Use from APS**

The APS survey of industrial physicists in the APS (9) reveals that they are divided into two main segments. The one familiar to APS and well served by it consists of physicists with institutional IT access to the literature (e.g., those in large & medium size firms as well as those in essentially all universities and government research laboratories). This access is purchased by the institutions with which they are associated and typically is provided to individual physicists without additional charge. These are the hard copy journal subscriptions and electronic information products (e.g., web access to journal archives) that currently are offered by APS and other American Institute of Physics (AIP) member societies.

There is, however, another sizable segment consisting of industrial physicists without institutional IT access to the literature (e.g., those in small firms, consultants, retirees). These individuals currently do not have access to the physics literature except by bootlegging such access as adjunct or other temporary faculty at an academic institution. They constitute, therefore, essentially a new market for APS and AIP technical information products offered over the web with pricing appropriate for individuals with modest usage requirements. Offering products and services to this market segment is one of the major opportunities for expansion of the electronic information products and services market by the APS and other AIP member societies.

This survey also reveals other important characteristics of industrial physicists who are members of APS. They

- are web-email-telephone oriented;
- use physics on the job;
- need physics information far beyond APS journals;
- usually belong to other professional societies as well as APS;
- rarely publish in APS journals or attend APS meetings;
- use APS journals once a year or less;
- are connected with APS primarily via *Physics Today*, *APS News*.

Therefore the survey presents a picture of industrial physicist members of APS who are at best loosely coupled to the APS and who desire and need a variety of information services that APS does not offer but that competitive societies like the IEEE are attempting to offer. The task force suspects that this is not a stable situation, and in subsequent sections offers a variety of recommendations to better serve and hence stabilize this segment of APS members (i.e., current customers).

### **3. APS Web Services Evaluation and Recommendations**

After extensive review of the results from the Industrial Physicists Survey (9), the members of the Task Force generated a list of potential services that would be most useful to industrial physicists (10). After prioritizing the list, the task force unanimously agreed that in their collective opinion the most useful service that APS could offer to its industrial physicist members is a physics analog to “myspace.com”, i.e., an on-line network of practicing physicists.

**Recommendation #1: The APS should establish and maintain a searchable, online network, similar to “myspace.com.” This online service would facilitate interactions and networking among industrial physicists and would contain a list of expertise.**

The task force realized that it did not have the expertise to pursue this recommendation. Further, it recognized that while APS has the technical and financial capability of constructing a web site capable of hosting such a service, the definition and oversight of this service must be done by competent and highly motivated volunteer members of APS. This is a massive task the success of which requires aggressive volunteer leadership. In an effort to identify an individual who might lead the implementation of this service, Mohsen Yeganeh contacted the FIAP Executive Committee and CCPD (Committee on Careers and Professional Development), as well as several FIAP members who have shown interest in serving industrial physicists. Professor Shadi Shahedipour-Sandvik (SUNY Albany), a close friend of FIAP, agreed to take the lead in assessing the feasibility such a service and pursuing its implementation. Professor Shahedipour-Sandvik can be contacted at: [SShahedipour@uamail.albany.edu](mailto:SShahedipour@uamail.albany.edu). ***The task force recommends that the APS create an internal working team to assess the feasibility of creating such a service and contact Prof. Shahedipour-Sandvik to explore this topic.***

**Recommendation #2: Improve the on-line search engine for APS meetings — Bulletin of the American Physical Society (BAPS)**

The online search engine <http://www.aps.org/meet/archives/index.html> for specific APS meetings (current meetings and archives) mostly serves those in the APS community who attend APS meetings. There are author, chair, and session indices, an epitome (schedule of sessions), and a list of invited speakers. The web site allows a simple word search of titles, abstracts, and institutions. The main purpose of this search engine is to help attendees plan their schedule at the meeting. Complex searches of the archives across multiple meetings are not possible. The database also seems to contain errors (for example, S. Zollner is listed as a coauthor of paper D15.00012 at the 2006 March meeting, yet he does not appear in the author index for the meeting).

For industrial physicists who often cannot attend APS meetings (7), it would be helpful to improve the BAPS search engine with the following goals: (a) Find experts in a certain field of physics who can be consulted about a problem. (b) Find students with certain skills for job openings. (c) Restrict the search to a geographic region to allow face-to-face interaction with experts without having to travel.

<http://units.aps.org/units/fiap/newsletters/index.cfm>

For all users complex searches (similar to Scitation or INSPEC) of the BAPS database should be enabled. The search engine should allow searching of the archives of all current and past meetings on line (back to 1993) with at least the following fields: author, title, abstract body, sorting category, institution, state, country, range of years, category of meeting (March, April, Section), etc. The APS should monitor the uptime of their search engine and aim for high percentage of uptime.

**Recommendation #3: Implement a robust search engine for the entire physics literature suitable for use not only by academic and large commercial users but also by individual physicists working as consultants or at small firms.**

The AIP product known as *Scitation* was singled out for examination as a potential example of such a search engine that already exists and could readily be made available to APS members. *Scitation* was selected because its publications contain forward links to other articles on the same platform. Forward links are links to articles that were published after a particular article that cite it. In addition, links between articles and editorially related material (for example, articles and errata, or comments and replies) are a platform standard. Links are also available to any author-supplied supplementary material (including multimedia) hosted on the *Scitation* platform.

A full description of what capabilities and services are offered using *Scitation* can be found at this link:

<http://scitation.aip.org/servlet/HelpSystem?KEY=SCI&TYPE=HELP/FAQ - ques1>

*Scitation* is a search engine, publicly available, that searches the literature currently generated by AIP and member societies (and in some case their historical archives) as well as certain other physics literature. Abstracts of the articles found are available free of charge. Since *Scitation* itself is not a subscription-based service, however, access to the journal articles published through AIP requires subscriptions from each member society. Thus, both the cost of subscriptions and the burdens of multiple accounts are on-line obstacles that inhibit many "non-academic", especially industrial, physicists from using these helpful resources. Nevertheless, as a search engine alone, *Scitation* is an attractive tool for industrial physicists, although perhaps less so to academic physicists who have access to other tools through their institutions. ***The task force recommends that the availability of this tool be publicized widely to APS members.***

The ultimate service that the task force envisages is the combination of this search engine with the availability of journal article packs (delivered via the web) across all AIP and member society journals. In order to examine the feasibility of such an offering, task force members volunteered to test a prototype of the offering under the guidance of Jerry Hobbs. Support and approvals from each Executive Director was given for a limited trial of such a pan-AIP journal subscription. Task force members were assigned user names and single passwords by the AIP On-Line Services staff. The trial period runs from mid-July through the end of September 2006.

Although the survey results of the *Scitation* search-engine and article-delivery trial are not yet available, it is generally considered a viable option that could easily meet the requirements of individual industrial physicists. Jerry Hobbs will make available a subsequent report on the findings of this trial to the APS Executive Board and AIP member society executive directors later in the autumn of 2006.

The most difficult barrier to overcome prior to offering such service to individuals will be parsing revenues for the provision of the articles equitably among the member societies to compensate them for their provision of access to their journal databases. The APS could be a leader in motivating AIP member societies to work through this barrier via a series of test offerings trying out various pricing and revenue sharing algorithms. This is the topic of recommendation #8.

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#### **4. Comparison of APS services to Industrial Physicists with Those of other Professional Societies**

The task force conducted an extensive survey of the industrial membership of other scientific and technical societies serving industrial physicists, and of the services offered to this segment of their membership. Information was collected on six other societies, American Chemical Society (ACS), Electro-chemical Society (ECS), American Vacuum Society (AVS), Institute of Electrical and Electronics Engineers (IEEE), Optical Society of America (OSA), and Materials research Society (MRS). This was done by examining the websites of the societies as well as interviewing individuals knowledgeable in the society, usually a staff member in the member department, or equivalent. The results are presented in appendix C.

Of the six societies, three have intensive industrial membership representation: ACS, IEEE and OSA. The ACS and OSA have greater than 50% industrial membership. While the IEEE provided no data, it does have a significant industrial focus. One common feature of the three industrial-led societies that they represent a well-defined business arena: chemical, pharmaceutical and petroleum industries (ACS), electrical and computer sciences (IEEE), and optical research and communication (OSA). The APS represents physics broadly rather than being focused on a particular business arena. This fact leads to the notion of the “hidden physicist” in industry because physicists are likely classified as engineers or technologists in the workplace.

The results presented in Appendix C reveal that APS has one of the smaller proportions of industrial physics members (20%) of all the societies surveyed. Moreover, it significantly lags leading societies like IEEE in (a) providing easy (web) access to pertinent literature (b) including industrial physicists in society governance and awards, and (c) running meetings of interest to industrial physicists. Given the small percentage of APS industrial members these findings are not surprising.

***Nevertheless, the “bottom line” of this survey is that APS lags other scientific and technical societies serving industrial physicists in providing to them benefits that they have indicated that they want (9) and that other societies provide in some form or another (Appendix C).***

##### **Recommendation #4: Greatly improve APS recognition and awards for industrial physicists.**

The paucity of professional recognition offered to industrial physicists by the APS has been the subject of anecdotal complaints for many years, especially the lack of industrial physicist Fellows. ***The task force recommends that this issue be addressed, any systematic shortfalls documented, and remedies put in place.*** APS should determine if an appropriate percentage of prizes and awards are given to APS members in industry. (Only one of 51 recipients in 2006 was from industry.) A similar determination should be made for elevation to Fellowship.

The task force suspects, but did not have access to the data to demonstrate, that industrial physicists receive far less than their proportional share of Fellowship, prizes and awards. If this turns out to be the case, steps should be taken to improve this share, for example by recognizing physicists (a) who have become successful outside of physics, (b) who have had an impact on society with a patent or product, or (c) have excelled in leadership or management of a company or other private institution. Mechanisms should be sought to improve recognition of industrial physicists similar to other underrepresented groups, such as women and minorities. For example, additional Fellowship slots could be awarded to FIAP with rules that the FIAP Fellowship committee and FIAP’s Fellowship nominees need to contain a certain percentage of

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industrial APS members. Important APS fellowship and awards committees (such as Fellowship Committee or Committees on Prizes and Awards) should include members to represent the interests of industrial physicists. Among the 29 APS prizes and 15 awards, very few are currently awarded to industrial physicists, who usually work in product development, not fundamental or applied research. The APS Pake Prize recognizes a physicist who has made contributions in both research and management or leadership, but there is no prize for an industrial physicist who meets only one of the criteria. Nominations for such recognition could come from APS members at academic institutions who seek to recognize their alumni. This issue is not unique to the APS among the societies surveyed. Nevertheless, it has been a continuing source of frustration and dissatisfaction of APS industrial members for at least the past decade, and deserves to be addressed in a forthright fashion.

During the course of its deliberations, the task force became aware of certain subtleties in implementing this recommendation, which are worthy of being called to the attention of the APS leadership. These result from the fundamentally different value systems of academic and industrial research. Academic (and most government) research is valued primarily on the basis of its effect on the community as reflected in publications, citations, invited papers at conferences and the like. Industrial research, on the contrary, is valued primarily on the basis of its impact on the commercialization of a new product or service. Publications and conference presentations are at best secondary, and often are explicitly discouraged in order to protect the intellectual property resulting from the work. To reward outstanding industrial physics research, prize, award and fellowship committees must be comprised of individuals that understand the industrial research value system and can evaluate candidates accordingly.

The subtleties arise from the fact that the differences between the value systems also create a situation in which APS fellowship and awards committees, which are appointed at the unit level, are comprised predominately if not exclusively of physicists employed at academic and government institutions. FIAP affords an illuminating example of this dynamic in action. While its original leadership was almost exclusively industrial physicists, over time it has come to be increasingly dominated by academic or government physicists who, naturally, apply their own value system in selecting Fellows, prize and award winners. This has occurred because APS members attracted to FIAP have been primarily applied physicists from these environments who get rewarded for their participation in FIAP activities like invited paper sessions at APS meetings or FIAP governance functions. Industrial physicists do not get similarly rewarded, so they are less motivated to participate. This fact was reflected in the industrial membership survey (9) by the observation from the write-in comments that many if not most of the members surveyed were unaware of FIAP or its activities. This was much less of an issue fifteen years ago when large firms like AT&T, IBM, GE, Dupont, Dow, GM, Ford, Xerox and the like sponsored large central research laboratories one component of which was the pursuit of basic research in physics. The physicists in these firms who performed such research were rewarded for their participation in APS affairs and were well represented on APS unit governance. As noted earlier, however, in the new global economy these institutions have disappeared and with them the pool of APS industrial physicist members who actively participate in its meetings and publications. ***Therefore the task force recommends that special efforts be made to secure more active participation of its industrial physics members in APS unit governance, especially prize and award committees, if the APS wishes to encourage this class of membership.***

**Recommendation #5: The APS should sponsor a prize for the industrial applications of physics in the biannual years that the AIP Prize for the Industrial Applications of Physics is not offered.**

The AIP currently offers a biannual prize to recognize outstanding contributions by an individual or team to the industrial applications of physics. This is the only physics prize given exclusively for industrial applications of physics. In recent years there have been ample nominations for this prize to support the annual award of such a prize. Moreover, if a new prize were offered in the

intervening biannual years, special conditions could be placed on this new offering, e.g., to individuals or teams from small firms. Thus, the combination of funding for an additional prize for the industrial applications of physics coupled with some special restrictions to target underrepresented industrial physicists in the APS is a simple, actionable proposal to double immediately the prizes offered for the industrial applications of physics as well as introduce a new APS prize for such contributions.

## **5. Exploration of Potential Partnerships**

One of the major findings of the APS survey of its industrial members is that these individuals use a large cross section of the technical physics literature that far transcends the scope of APS journals. The literature that they wish to access via search engines and use via simple, convenient web access is the entire panoply of AIP and member society journals, together with as much of the additional physics literature as possible. Thus, the task force suggests that the greatest service that APS and other AIP member societies can offer to individual industrial physicists who are their members is to come together and offer convenient web searches coupled with web-based journal article packs which encompass all AIP and member society journals. Moreover these offerings should be tailored to individual physicists who do not have access to large institutional library subscriptions. This would enable the small firms and consultants, the wellsprings of much of the innovation in the US, to access the physics literature on an even playing field with their better-funded (usually at taxpayer expense) brethren. It also offers AIP and member societies an opportunity to expand their offerings to include new products and services uniquely tailored to create new markets in the age of the global internet.

### **Recommendation #6: Expand APS journal article packs**

Currently, APS article packs (copies of individual articles delivered over the web) are restricted to APS journals (*Physical Review* and *Physical Review Letters*) and limited to issues from the last three years. Twenty articles currently cost 50 dollars (very reasonable). A hardcopy printed from the downloaded PDF article and results of journal searches are for personal use only and may not be shown to others. This policy is not suitable for industrial physicists for three reasons: (a) Industrial physicists usually work in an interdisciplinary environment and need access to journals from a broad range of fields. (b) Quite often, it takes 10 or 20 years or even longer for a physics discovery to become relevant for industrial product development. Therefore, older papers are often more useful for industrial physicists than more recent ones. (c) Industrial physicists usually work in teams, not alone, usually with people from other fields who are not likely to APS article pack licensees. A printed hardcopy is useless, if it cannot be shown to coworkers.

***Some changes to the current offering can be made immediately. First, the journal period for article packs should be expanded to include all on-line issues of APS journals (e.g., The Physical Review from its first issue over a hundred years ago, not just the last three years). Second, the terms of use should be at least as permissive as those for a purchased book. A subscriber should be allowed to print one copy of the downloaded PDF file and circulate it within his/her company as long as no copyright laws are broken (e.g., no additional copies to be made without payment of a royalty fee).***

One of the primary findings of the survey of APS industrial members (9) is, however, that industrial physicists need access to all of the physics literature not just APS journals. Thus, the APS cannot meet their needs without cooperative arrangements with other creators and publishers of physics literature, especially the applied physics literature. This finding motivates recommendation #8, described below.

**Recommendation #7: Create new classes of membership, attractive to industrial consultants and physicists employed at small firms, which bundle journal article packs with the membership fee.**

While it may not be economically feasible to include free access to APS journals as a membership benefit, some scientific societies (e.g., AVS and MRS) offer some free online publication access to their members (see Appendix C). This access is especially valuable to APS members in industry and APS senior members, since students, professors, and government researchers usually have access to journals through their institutions, while other physicists usually do not have journal access. We suggest two alternative approaches to such new offerings.

**Teaser memberships:** The APS could include a small number of APS articles (a “teaser” article pack) free with membership. This would be a marketing tool with the intent that members would purchase additional articles if they find the first few articles useful. Many companies (internet service providers, cable TV companies, etc) offer a free month to recruit new customers. Why not give away a few free articles to generate more revenue?

**Industrial physicist memberships:** The task force recommends generating a new type of membership, which would initially include a ten-article pack (all APS journals, not limited to the last three years) with membership dues that are 25 dollars above the basic APS membership rate. As noted earlier, however, industrial physicist members of APS need and want access to all the physics literature, not just to APS journals. Thus, to be attractive to industrial physicist members of APS, the scope of the article pack in this new class of membership probably will need to be extended to other AIP and AIP member society journals. This is the topic of recommendation #8 below.

**Recommendation #8: Work with other AIP member societies to create all-AIP-and- member-society journal packs for individual APS members and to allow AIP and member societies to create similar offerings to small firms as well as individual members.**

This is a hugely important recommendation. From the perspective of the findings of our surveys, it is evident that APS and other industrial physicists are interested in journal packs that cover all the journals published by AIP and its member societies rather than those encompassing just the journals of a particular society. This recommendation basically suggests to the APS leadership that they do the obvious: Give the customers what they want. From a more strategic perspective, this class of physics information services will bring access to the physics literature to the people who are most likely to generate economic value from it, i.e., physicists and engineers employed by small firms. This is what the APS is all about: Disseminating the knowledge of physics to the folks that can use this knowledge to create products and services that serve mankind and generate economic prosperity. This is a high calling for the APS in the 21<sup>st</sup> century.

The attributes of these services are straightforward. For example, a new subscription class that “bundles” a pre-set number of articles could be created through cooperation among AIP member societies. If there were common views among AIP Member Society Executive Directors--they acknowledge the rapidly changing and specialized roles that prospective industrial members serve in the greater community--then they could cooperate to offer broad-based journal article packs that include articles from the journals of multiple AIP member societies as well as AIP itself. Our survey (9) reveals that physicists working in smaller and medium sized companies are requesting precisely this sort of web-based electronic technical information products.

A site-licensed “Industrial Class Journal Package” or bundle of 5 or 10 articles might be easily purchased through infrastructure set up by AIP Online Services. The validation could be set to access and download both current and historical entries. Further, the bundle could be given a “time stamp” that would expire within a brief period--say becoming invalid after six months from purchase.

Administrative time, capital and operating costs are required to create such bundled “Industrial Class Journal Packages”. These and other issues would have to be discussed among member societies and AIP staff to reach agreement. As discussed in association with Recommendation #3, deciding how to parse out revenues among member societies whose journals are accessed through such AIP-delivered services is a delicate topic. The benefits to those individuals focused on industrial physics are, however, clear. Making broader ranges of subject areas and expertise readily available enables innovative ideas and the more rapid commercialization of new products and services based on physics research knowledge. The logistics of equitably sharing the income resulting from the industrial class journal packages is a significant problem that must be resolved.

There are external examples of bundled journals provided for a fee. INFOTRIEVE is a company that serves the needs of those who are working in small- and medium-sized companies. Like INFOTRIEVE, AIP could take the role of a physics information broker and provide PDF files of scientific articles to subscribers for a fee, collect the fees, and redistribute them among the AIP member societies or other entities owning the copyright to the downloaded PDF files. This would open the road to AIP-wide article packs that allow access to articles published by AIP and all AIP member societies (and perhaps even some societies outside of AIP through reciprocal relationships). The scope of this view transcends the APS so the task force does not offer it as a recommendation. But ***the APS can take a leadership role within the AIP in making this happen, and we recommend that course of action.***

## **6. Wrap-Up**

During the past 20 years the world has changed profoundly requiring physics and physicists to do likewise. These changes are affecting the APS in three major ways. First, the creation of economic value from physics research and the industrial employment of physicists are increasingly becoming primary value propositions for physics to secure funding from the public purse. The shock troops that generate this value are industrial physicists. Thus, industrial applications of physics created by industrial physicists are becoming the primary currency to motivate incremental governmental investments in physics research and education. Second, the employment of PhD physicists is increasingly in industry as opposed to government and academia. Therefore the jobs for which the academic physics profession is supposed to prepare its graduates are changing in character relative to the decades of the 1950s through 1980s. Third, the relative competitive attractiveness of physics education and employment in the US is declining. Opportunities for physics research and education are increasing in both Europe and the Far East. Rapid technological growth is migrating away from the physical sciences into information technology and biotechnology. These trends all point to a future for physics and physicists, which is rather more challenging than the past: A future in which industrial applications of physics and industrial physicists are increasingly important to the health of the whole profession. Because of this the APS leadership is rightly concerned with supporting the activities of its members who are industrial physicists and with bringing their contributions to the attention of government funding agencies.

One particular aspect of this situation is the demise of the large corporate US R&D laboratories that performed basic research in physics. This, in turn, has deprived APS of a sizable pool of industrial physicist members whose research was quite similar to that of academic physicists and the value of whose work was judged on a similar basis (e.g., impact on the community as measured by publications, conference presentations, invited papers etc.). The remaining industrial physicists in APS are increasingly employees of small firms and consultants, the value of whose work is judged primarily on the basis of its impact on the value of commercial products and the speed of commercialization. Moreover, these industrial physicists typically do not have access to institutional subscriptions to APS and other physics technical journals. This is a distinct community of APS members, quite unlike the traditional industrial physicist community drawn

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from large industrial R&D organizations. As noted above, this fact complicates the serving of this community by APS because traditional APS offerings like journal subscriptions and meetings are not widely used by this class of industrial physicists.

The APS leadership commissioned this Task Force for Industrial Physicists that has done its job of collecting data to define the needs of APS industrial physicists, comparing current APS offerings in this arena with those of other professional societies serving this market, and providing specific recommendations for new APS offerings that will enhance the value of APS membership and offerings to its industrial members. The task force has tried mightily to offer simple and actionable recommendations. One of its major findings is that industrial physicists want and need convenient and inexpensive access to a broader swath of the physics literature than that generated in APS journals. ***The APS can make its greatest contributions to the creation of economic value via the diffusion of the knowledge of physics in the networked 21<sup>st</sup> century through collective action with other physics societies to offer physics information products and services that span all of physics and that are conveniently available over the web at low cost. Moreover, it can take a leadership role in creating and offering such products and services within the AIP framework.*** The task force encourages the APS leadership to place a top priority on achieving these objectives.

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## **Appendix A: Charge to the APS Task Force for Industrial Physicists**

The nature of industrial physics has undergone significant changes in the last decade and the Task Force for Industrial Physicists will work to enable the APS to expand and improve its services to this large and important segment of the physics population. The task force will report to council on the following activities:

1. Collaboration with staff and consultants in modernizing the APS web site, for example, by identifying and evaluating web-based connectivity and networking tools which facilitate participation of all APS members.
2. Investigation of the programs and services AIP member societies and other societies such as the MRS, ACS, and IEEE offer to industrial members.
3. Exploration of potential partnerships with other societies to jointly leverage these offerings for the benefit of APS members.

## **Appendix B: Roster of Task Force for Industrial Physicists**

**Charles B Duke** (*Chair*)  
Xerox Corporation, retired  
1168 Hidden Valley Trail  
Webster, NY 14580-9176

**Alex F Panchula**  
2836 Roland Avenue  
San Carlos, CA 94070-4352

**Stefan Zollner**  
Freescale Semiconductor, Inc.  
3501 Ed Bluestein Blvd.  
Austin, TX 78721

**Mohsen Yeganeh**  
Exxon Research & Engineering  
Rte 22 East  
Annandale, NJ 08801

**Chris Armstrong**  
Keithley Instruments  
28775 Aurora Rd  
Solon, OH 44139

**\*Snezana Bogdanovich**  
Hologic Inc.  
Direct Radiography Corp  
600 Technology Drive

<http://units.aps.org/units/fiap/newsletters/index.cfm>

Newark, DE 19702

**\*Jennifer J Zinck**

HRL Laboratories, LLC  
3011 Malibu Canyon Rd  
Malibu, CA 90265

**\*Stephen C Ems**

Lecroy Corp  
700 Chestnut Ridge Rd  
Chestnut Ridge, NY 10977

**Jerry Hobbs**

Director of Industrial Outreach AIP

**Judy R Franz**

Executive Officer, American Physical Society

**\*Michael S Lubell**

Dept of Phys CCNY-CUNY

\*Resigned from Task Force

## Appendix C: Services offered to Industrial Physicists by Professional Societies

Society	Industrial Membership	Total Membership	Free subscriptions with membership	Other Benefits	Website
American Physical Society	20%	45000	<i>Physics Today</i> , <i>APS News</i>	Membership directory, Insurance, discounts, AIP services	Phys. Rev Focus, Career Center,
American Chemical Society	60%	150000	<i>Chemical &amp; Engineering News</i> (online and print versions) and <i>Chemistry</i> online member-magazine	Insurance program, Mortgage financing, Credit card, Consumer line of credit, CD, Auto rental discount (Hertz, Budget, Avis, Hotel discount, Moving assistance, and Travel programs	extensive chemistry website, with publications and research resources in addition to ACS-specific information.
Electro-Chemical Society	34%	7784	Access to ECS Digital Library	Meetings, membership directory, some discounts.	Launched the new web site and the digital library
American Vacuum Society	42%	4000	Subscription to <i>JVS&amp;TA</i> and <i>B</i> ; <i>Physics Today</i>	Group insurance, Hotel discount, AIP services, AVS quarterly, "networking opportunities", Career networking service, Membership in up to 2 local AVS chapters	Buyer's guide and reference guide, Membership directory
IEEE	N/A <sup>1</sup>	360000 <sup>2</sup>	<i>IEEE spectrum</i>	Access to technical publication are a big draw for members Insurance, proceedings of the IEEE, home and office supplies(?), travel	Access to IEEE xplore, Careers.ieee.org
Optical Society of America	53% <sup>3</sup>	>14000, 64% within the US	<i>JOSA A</i> , <i>JOSA B</i> , <i>Optics letters</i> or the <i>Journal of Optical Networking</i> free of charge, or you may select <i>Applied Optics for a discount</i> , + <i>Physics Today</i>	OSA's research indicates that journal and networking is considered a significant benefit. Beta-testing new on-line networking.	www.workinoptics.com is an extremely popular website for people looking for jobs in optics with the majority of posting from companies. Rolling out new website in the fall
Materials Research Society	21%	13500	<i>MRS bulletin</i> (free) Discounted MRS proceeding and JMR	"MRS alerts", Membership directory	Three level of website access: open, registered user, and member; "Material connection" and "Career central" available on the web

- Note
1. IEEE does not classify members by occupation, but by technical interest
  2. World-wide
  3. OSA defines non-academic as individuals not working at colleges, university and institutes.
  4. Data provided from on-line sources and conversation with  
 Gail Oare, MRS  
 Beth Hampton, Alison Reznick, OSA  
 Director of membership at ACS  
 Felicia Taylor, IEEE  
 Yvonne R. Towse, Administrative Director, AVS  
 Heidi Rixman, Director of Membership and Development, ECS