

PARTICULARS

e-Newsletter of the [Particle Engineering Research Center](#)

Particle Engineering Research Center

Fall 2009

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Cancer remains one of the most urgent public health concerns in the United States today. The Surveillance, Epidemiology and End Results (SEER) Program estimates 1.5 million new cases of cancer in 2009 along with over half a million projected deaths. According to global estimates, nearly 70% of deaths due to cancer occur in middle- and low-income countries. Inefficiencies and inabilities of modern clinical diagnostic and therapeutic methods have led to

skyrocketing treatment costs, furthering socio-economic class divisions in treatment outcomes as well as financially impacting the nation. Research and development in the areas of nanoscience and nanotechnology promise to provide innovative, and more effective, approaches for early diagnosis, imaging and therapy. An emerging trend in this direction is *Theranostics*, which represent a *combinatorial diagnosis and therapeutic approach to cancer disease* and aims to eliminate multi-step procedures, reduce delays in treatment and ease patient care.

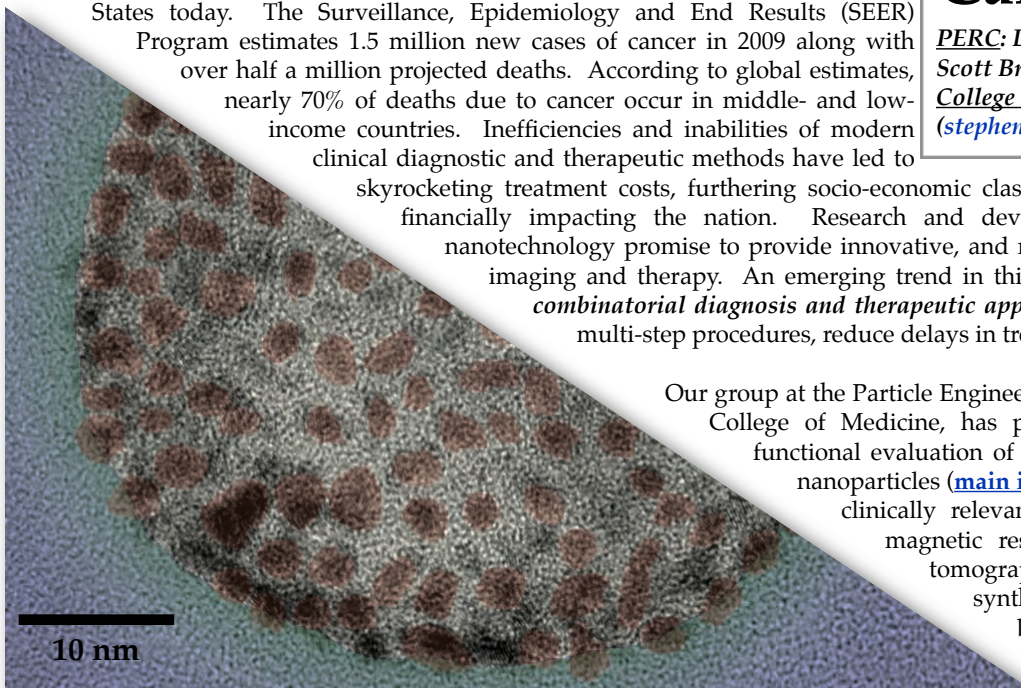
Cancer Theranostics

PERC: Dr. Parvesh Sharma (psharma@perc.ufl.edu), Dr. Scott Brown (sbrown@perc.ufl.edu)

College Of Medicine: Dr. Stephen Grobmyer (stephen.grobmyer@surgery.ufl.edu)

Our group at the Particle Engineering Research Center, in collaboration with the College of Medicine, has previously demonstrated the fabrication and functional evaluation of Gadolinium-doped gold speckled silica (GSS) nanoparticles ([main image at left](#)) as multimodal contrast agents for clinically relevant, non-invasive imaging modalities such as magnetic resonance imaging (MRI) and photo acoustic tomography (PAT). Prepared through a simple one-pot synthesis using microemulsions, GSS particles can be fabricated with a size range from 30 to 200

[Continue](#)



~ Table Of Contents ~



[Director's Desk](#)

A short message from the Director of PERC...



[Education & Training](#)

Updates on PERC's education efforts and student research...



[Innovations & Technology Transfer](#)

From cutting-edge research to commercial applications...



[Industry Spotlight](#)

An in-depth look at one of our valued industry members...



[Featured Research](#)

Ongoing particle science and engineering research at PERC...



[Latest News](#)

Selected publications, upcoming events and funding opportunities...

Particle Engineering Research Center (PERC)

Since being launched in 1994 at the University of Florida as an 11-year Engineering Research Center funded by the National Science Foundation (NSF), PERC has served as a unique catalyst for synergistic interdisciplinary collaborations that have led to over \$50M invested in cutting-edge research, the education of more than 800 students, fruitful collaborations with over 100 companies and the successful transfer of more than ten particle-based technologies. Through these efforts, PERC has garnered international recognition as a world leader in particle science & technology (PS&T) and continues to recruit a talented and dedicated cadre of young professionals and researcher staff since its graduation from NSF funding in 2005. With fifteen years of experience in the research, development and facilitating commercialization of particulate based systems, PERC has become a leader in the field of PS&T and is now looking forward to an exciting future. PERC has created a strategic plan that capitalizes on its strengths, addresses its weaknesses, and allows the Center to grow while pursuing its mission to "innovate and transform particle science and technology advances into useful applications for sustained societal well-being."



[Home](#)

CPaSS I/UCRC

The Center for Particulate and Surfactant Systems (CPaSS) is a joint National Science Foundation (NSF) Industry/University Cooperative Research Center (I/UCRC) between the University of Florida (UF) and Columbia University (CU). The Center started its activities in April 2008, and leverages the expertise, resources and experience of the Particle Engineering Research Center at UF and the Industry/University Center for Surfactants (IUCS) at CU.

The mission of CPaSS is to advance, develop and promote fundamental understanding of particulate and surfactant systems leading to their enhanced performance and minimal environmental footprint. This mission will be accomplished by achieving the following goals:

1. Advancing the fundamental understanding of the particulate – surfactant interactions;
2. Establishing a venue for industrial/academic interactions for conducting industrially relevant research;
3. Exploring high-risk, high-impact research that could lead to technological innovations; and,
4. Promoting education and training of students in this important field.

Inquiries concerning CPaSS membership:

Dr. Maria Palazuelos
(mpalazuelos@perc.ufl.edu)
Dr. Rodney S. Guico
(rguico@perc.ufl.edu)

[Home](#)

Director's Desk *A short message from the Director of PERC...*

Welcome to the reissue of *Particulars*, our e-Newsletter which highlights the latest news at the Particle Engineering Research Center (PERC) including innovative research and technology advancements. We intend to make it a periodic publication for everyone to enjoy!

In this issue, you will find information regarding PERC's approach to using particles for novel cancer diagnosis and treatment options, mold growth inhibition and mycotoxin extraction from the environment. We also take a detailed look at one of our industry partners, Beckman Coulter.

Some of you may remember *Particulars* from a few years ago. In redesigning the newsletter, we are taking an environmentally sound approach by distributing the newsletter electronically with a printer-friendly layout. The electronic format will allow you to further explore content in the included web sites and email links.

If you have any comments, questions or suggestions, or would like to contribute to future issues, please feel free to contact us at info@perc.ufl.edu. We look forward to hearing from you!

Dr. Brij M. Moudgil
Director of PERC (NSF), CPaSS (NSF) & CNBS (State of FL)
Professional Web site: <http://perc.ufl.edu/moudgil/>

Learn who is collaborating with PERC:
<http://www.perc.ufl.edu/moudgil/collaborators.asp>



Dr. Brij M. Moudgil

Distinguished Professor and Alumni Professor of Materials Science and Engineering

Email the Director
(bmoudgil@perc.ufl.edu)

[Home](#)

Center for Nano-Bio Sensors (CNBS)

The Center for Nano-Bio Sensors (CNBS) is a Center of Excellence funded by the State of Florida to develop and commercialize novel nano-bio sensors for medical diagnostics and homeland security applications by capitalizing on high payoff technologies that can be brought to market rapidly and establishing a sustainable platform for economic growth and high tech job creation across the State of Florida and the Nation. CNBS (<http://cnbs.centers.ufl.edu/>) and PERC leverage on their management, resources and administrative support. Since its inception in 2007, CNBS has focused on:

- Promoting basic research for industrially relevant research with targeted deliverables
- Transferring technology and cooperating with industrial partners for commercialization
- Educating and training a specialized nano-bio workforce

CNBS funding is dedicated to sponsoring the development of selected technologies into a prototype stage that will facilitate their licensing and commercialization. Projects are rated on several parameters, including economic impact, stage gating and path to market. Once a project becomes part of the CNBS portfolio, it is periodically evaluated for progress towards future goals.

[Home](#)

Innovations & Technology Transfer *From cutting-edge research to commercial applications...*

In a recent study by the prestigious Milken Institute (<http://www.milkeninstitute.org/>) titled "Mind to Market: A Global Analysis of University Biotechnology Transfer and Commercialization," the University of Florida (UF) was listed as the top-performing public institution at transferring its research to the marketplace. UF has consistently ranked in the top-5 overall on the institute's University Technology Transfer and Commercialization Index. The study compared university technology transfer processes around the world, evaluated the common characteristics to successful commercialization and measured the role of the university offices of technology transfer. UF made a commitment a number of years ago to expand its commercialization efforts and its Office of Technology Licensing (<http://www.research.ufl.edu/otl/>) has the people and resources necessary to identify promising technologies, pursue patents and negotiate fair licenses.

[Home](#)

Novel Applications of Polyhydroxy Fullerenes

PERC: Dr. Vijay Krishna (vkrishna@perc.ufl.edu)

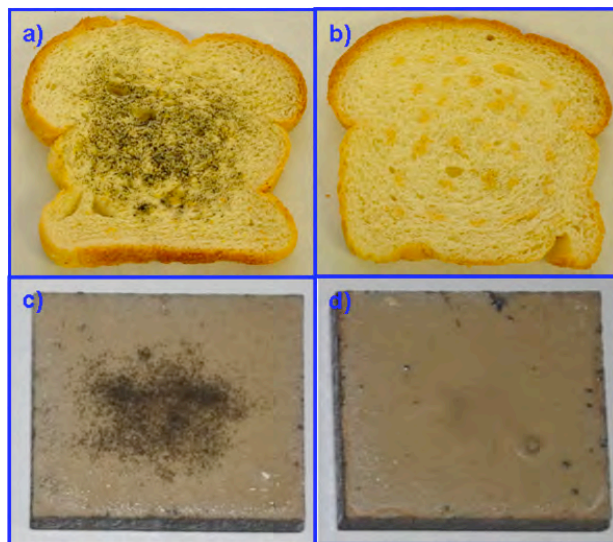
Environmental Engineering Sciences: Dr. Ben Koopman (bkoop2@gmail.com)

PERC researchers are developing technology to stop mold growth and diagnose and treat cancer with low-powered lasers, all using Buckyballs that have been modified to make them biocompatible, biodegradable and water-soluble. These modified Buckyballs (also known as fullerols or fullerlenols or polyhydroxy fullerenes) are already commercially available.

We applied a small amount of polyhydroxy fullerenes (PHF) to one slice of bread and then exposed the bread to the mold *Aspergillus niger*. Another bread slice without the PHF was also exposed to the mold. As shown in the figure, after three days in a humid environment, the bread with PHF showed no growth of mold, whereas the bread without PHF was covered with mold. A similar experiment carried out on tile showed the same result, i.e. PHF stopped the growth of mold. Our research team members foresee a huge market for this new antifungal agent. For example, fungal diseases in plants cause more than \$9 billion annual losses in the U.S., and fungal infections are the third most common life-threatening systemic infection that afflicts hospital-bound patients.

Another exciting property of PHF discovered by the PERC researchers is its ability to disrupt cells when activated by low-intensity laser light. In experiments conducted with the Department of Surgery at UF, tumors in mice were injected with PHF-containing nanoparticles followed by laser activation. Within one day, the tumors disappeared. Tumors exposed to laser without PHF injection showed no change. The researchers also demonstrated that the same PHF-containing nanoparticles, which are effective in treating cancer, can also be used for cancer diagnosis. Market potential for this technology is very significant, as cancer is one of the leading cause of deaths, with an estimated 9 million deaths in 2015. The U.S. market for cancer therapy products and services is expected to reach \$27 billion by 2009.

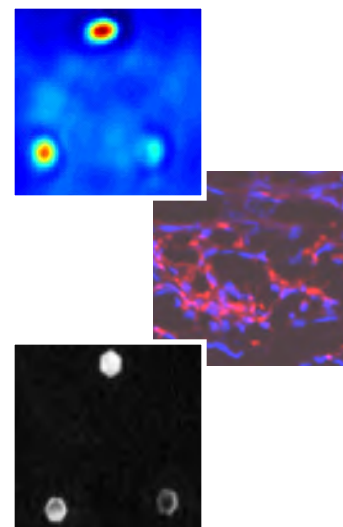
[Home](#)



*Growth of *Aspergillus niger* on a) and c) control, and b) and d) PHF coated bread (top row) and tile (bottom row) after three days of incubation in the dark at room temperature and 90% relative humidity.*

Featured Research *Continued from front page...*

nanometers. The [top and bottom images at right](#) show the PAT and MRI image, respectively, from the same phantom containing GSS nanoparticles, demonstrating the ability to image the nanoparticles simultaneously. The GSS nanoparticles have a silica core whose surface is composed of discontinuous, irregular gold nanodomains of varying crystallinity incorporated in the supporting silica matrix ([main image](#)). The multitude of dielectric-metal interfaces present in the particles allow them to absorb a broad spectrum of light, from the visible to the near-infrared (NIR) region, enabling unique photothermal properties that facilitate the use of these materials as ablation agents. In the NIR window (650 to 900 nm), tissues, hemoglobin and water have relatively low absorption and, thus, allow for deep tissue penetration and non-invasive therapeutic ability. In addition, the integration of a fluorescent dye within the silica core creates readily image-able markers for high-throughput *in vitro* fluorescence assays and *ex vivo* histopathological analyses. The [middle image at right](#) is an *ex vivo* fluorescent image of a tissue section from mice indicating the presence of the particles (red fluorescence) within the tumor. Doping the GSS with NIR dyes also allows the particles to be tracked *in vivo* and, thus, have the potential of performing image guided therapy. The unique silica-gold surfaces are suitable for bioconjugation strategies, enabling single and multivalent targeting. The GSS nanoparticles are comprised of materials (silica and gold) with a well established safety profile. The ability of these particles for optical (fluorescent) imaging and photothermal ablation has also been demonstrated *in vitro* and *in vivo* by our group.



[Home](#)

Education & Training *Updates on PERC's education efforts and student research...*

The education of students and professionals in the engineering practice of particle science and technology is an integral part of PERC's mission. The educational philosophy of the Center is to develop innovative educational approaches that foster interdisciplinary, systems-related learning. Curriculum development is one of the key features of the PERC's education program along with the recruitment of top-quality students. PERC is committed to increasing the number of students, including women and underrepresented minorities, who participate in particle science and technology education efforts and research. These ongoing efforts and programs will be highlighted in every issue of *Particulars*.

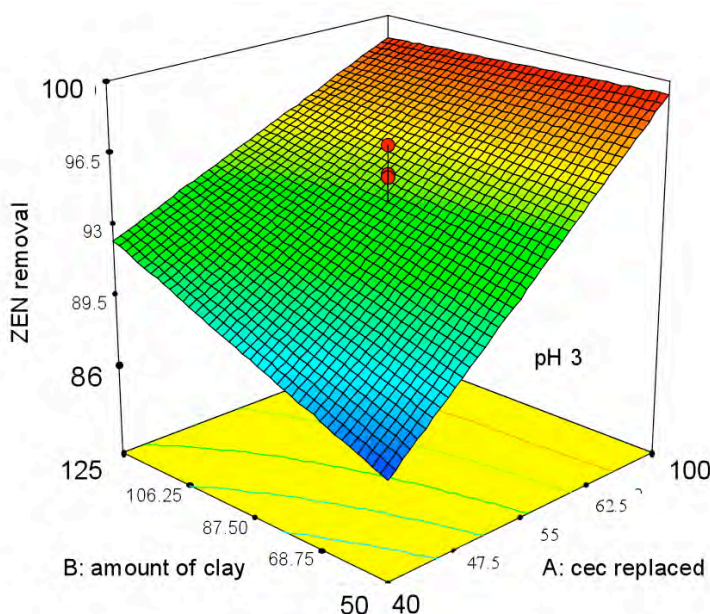
[Home](#)

Modification and Characterization of Montmorillonite Clay for the Extraction of Zearalenone

PERC: Dr. Kerri-Anne Hue (kahue@ufl.edu)

PERC Thesis Advisor: Dr. Hassan El-Shall (helsh@perc.ufl.edu)

Mycotoxins are secondary metabolites of organisms belonging to the fungus kingdom. The cost associated with mycotoxin contamination in the U.S. and Canada is approximately \$5 billion. Zearalenone (ZEN), a resorcylic acid lactone, is produced by various members of the genus *Fusarium*. These fungi often colonize a variety of foods and feedstuffs, including corn, sorghum, wheat, oats, barley and other cereal grains. This metabolite has estrogenic effects in farm animals with pigs being the most sensitive. ZEN induces hyperestrogenism and can cause infertility, reduced sex drive, fetal mummification and abortions.



Zearalenone extraction percentage as a function of the amount of organophilic clay added and the cation exchange capacity replaced by surfactant. Plot curvature indicates an interaction between the two parameters.

Clays have successfully been used in the animal feed industry as an adsorbent and binders for certain small, water soluble mycotoxins. These mycotoxins are attracted to the electrical imbalance between the layers of the clay where they can be sequestered and pass harmlessly through the animal. However, ZEN is water insoluble and is not extracted easily with phyllosilicate clays. Therefore the modification of montmorillonite clay with organic cations has been proposed to render the clays hydrophobic and increase the ZEN binding capacity.

The goal of this study was to develop a safe and cost-effective organophilic that is able to bind and extract zearalenone, to investigate the factors most applicable to extraction, and to investigate the fundamental properties between the clay-surfactant-mycotoxin systems that lead to extraction. The clay was modified by cation exchange reactions with tricaprilmethylammonium (TCMA) chloride and generic corn oil. The organophilic clays were then characterized using XRD, FTIR and TGA analytical techniques. These techniques determine the change in fundamental clay properties that would lead to the extraction of ZEN. Desorption studies were performed to ascertain if there was any increase in toxicity that might be caused by washing of the clays or exposure to electrolytic solutions. Statistical design of experiments (DOE) was used to establish the most influential factors during ZEN extraction. The clays developed were able to extract >90% ZEN *in vitro* at pH3 and pH7. The factors most relevant for extraction changed

depending on the levels of the parameters chosen. Mathematical models indicated the relationship between the factors and the ZEN removal percentage.

Kerri-Ann Hue, a native of Kingston, Jamaica, received her Bachelor of Science degree in Materials Science and Engineering from the Massachusetts Institute of Technology in 2002. She began graduate school the following fall at the University of Florida when in 2005, she earned a Master of Science degree. She recently defended her doctoral thesis work in August of 2009. Hue said, "Graduating with a Ph.D. in Materials Science and Engineering is going to be one of my biggest achievements."

As for future plans, Hue is open to many possibilities. "I'm open for options," Hue said. "I would like to be a professor or work with industry doing research."

[Home](#)

"...Nano For The Rest Of Us" Is In The News!

A seminar series developed at PERC by Dr. Brij M. Moudgil, Dr. Rodney S. Guico and Dr. Georgios Pyrgiotakis was recently featured in the *Alligator* (http://www.alligator.org/articles/2009/10/08/news/campus/091008_nano.txt), the student newspaper at the University of Florida. Additional information about the course may be found at <http://perc.ufl.edu/nano/>. Look for a complete roundup of the initial offering of this unique course in the next issue of *Particulars*!

[Home](#)

Industry Spotlight *An in-depth look at one of our valued industry members...*

Beckman Coulter -- Particle Analysis Founders, Technology Leaders

Particle scientists have access to a line of instruments and technical expertise with a wide range of applications through Beckman Coulter, Inc., a company whose history is closely interwoven with the field of particle analysis. Instruments are available for particle sizing, particle counting, zeta potential measurement and zeta potential measurement of flat surfaces.

Using The Coulter Principle, also known as ESZ (Electrical Sensing Zone Method), the Multisizer™ 3 and Multisizer 4 COULTER COUNTER® instruments provide particle count and concentration, as well as number, volume, mass and surface area size distributions in one measurement, with an overall sizing range of 0.4 µm to 1,200 µm. Unit response is unaffected by particle color, shape, composition or refractive index. The unit's Digital Pulse Processor provides ultra-high resolution, multiple channel analysis and accuracy, and offers information about such sample behaviors as cell volume change, dissolution and agglomeration.

LS™ 13 320 Series Laser Diffraction Particle Size Analyzers offer a system of multifunctional particle characterization tools. Patented state-of-the art, laser-based technology permits analysis of particles without the risk of missing either the largest or the smallest particles in a sample. The LS 13 320 technology is based on theories of light scattering, and differs from other laser-based instruments by virtue of a wide dynamic size range, number of size channels, and sample measurement options.

Delsa™ Nano Zeta Potential and Submicron Particle Size Analyzers use photon correlation spectroscopy (PCS), which determines particle size by measuring the rate of fluctuations in laser light intensity scattered by particles as they diffuse through a fluid. The instruments also use electrophoretic light scattering (ELS) to determine the electrophoretic movement of charged particles under an applied electric field from the Doppler shift of scattered light for zeta potential determination. Instrument capabilities include conventional static and automatic titration measurements for both size and zeta potential distributions of suspended particles. The Delsa Nano also can measure the zeta potential of a solid surface or film.

The SA™ 3100 Surface Area and Pore Size Analyzer with automated dewar lift is a complete system with integrated outgassing stations and vacuum pump. This benchtop BET surface area and pore size analyzer uses the static dosing method, a reference method that uses helium to measure the sample tube free-space for highly accurate data. It provides single and multipoint surface area analysis, multi-gas capability for surface area and full adsorption capability.

With a heritage that includes industry founders Wallace H. Coulter and Joseph R. Coulter, Beckman Coulter is uniquely positioned to bring long tradition, wide-ranging science and technology, and high-level experience and technical expertise to particle scientists wherever they work. More information is available at www.CoulterCounter.com.



The Multisizer™ 4 COULTER COUNTER® provides particle count and concentration, as well as number, volume, mass and surface area size distributions in one measurement.

[Home](#)

CPaSS welcomes its newest UF site members, Sinmat and Syngenta!



[Home](#)

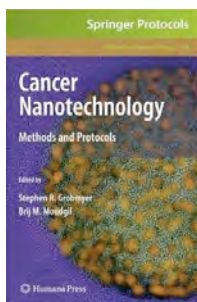
Latest News

Links lead to journal websites (Login required)

New Release

Cancer Nanotechnology

Grobmyer, S. R.; Moudgil, B. (Eds.) *Methods in Molecular Biology Series 2010*, Humana Press NY, NY. (February 2010)



Awards

Dr. Scott C. Brown, Advanced Powder Technology (APT) Distinguished Paper Award 2008, for "Influence of Shape, Adhesion and Simulated Lung Mechanics on Amorphous Silica Nanoparticle Toxicity"

Brown, S. C.; Kamal, M.; Nasreen, N.; Baumuratov, A.; Sharma, P.; Antony, V. B.; Moudgil, B. M. *Advanced Powder Technology* 2007, 18, 69. [Online]

Selected Publications

"Cell Death Discrimination with Raman Spectroscopy and Support Vector Machines"

Pyrgiotakis, G.; Kundakcioglu, O. E.; Finton, K.; Pardalos, P. M.; Powers, K.; Moudgil, B. M. *Annals of Biomedical Engineering* 2009, 37, 1464. [Online]

"Controlling Unconfined Yield Strength in a Humid Environment Through Surface Modification of Powders"

Stevens, N.; Tedeschi, S.; Powers, K.; Moudgil, B.; El-Shall, H. *Powder Technology* 2009, 191, 170. [Online]

"Gold-Speckled Multimodal Nanoparticles for Noninvasive Bioimaging"

Sharma, P.; Brown, S. C.; Bengtsson, N.; Zhang, Q. Z.; Walter, G. A.; Grobmyer, S. R.; Santra, S.; Jiang, H. B.; Scott, E. W.; Moudgil, B. M. *Chemistry of Materials* 2008, 20, 6087. [Online]

"Mechanism of Enhanced Photocatalysis with Polyhydroxy Fullerenes"

Krishna, V.; Yanes, D.; Imaram, W.; Angerhofer, A.; Koopman, B.; Moudgil, B. *Applied Catalysis B-Environmental* 2008, 79, 376. [Online]

[Home](#)

Fall IAB Meeting Update

The 2009 Fall IAB Meeting was held at Columbia University in NY on August 20th. Over 20 industry scientists representing 16 member companies were in attendance including several prospective member companies. The one-day program consisted of project updates, industry feedback and a poster session.

Project forms and presentations from the meeting are available online to current member companies only. If you are interested in joining CPaSS, please email Dr. Maria Palazuelos (mpalazuelos@perc.ufl.edu), I/UCRC CPaSS Florida Site Director, or Dr. Rodney S. Guico (rguico@perc.ufl.edu), Assistant Manager to the Industry Program, with any questions.

We would like to thank those CPaSS members who were able to attend the meeting. We hope to see all of you on February 17th-18th, in Gainesville, FL, for the 2010 Spring IAB Meeting!

Funding Opportunities

February 3rd, 2010

Collaborative Opportunity for Research Between I/UCRCs (CORBI)

National Science Foundation

<http://www.nsf.gov/pubs/2010/nsf10008/nsf10008.pdf>

February 17th, 2010

Fundamental Research Program for I/UCRCs (FRP)

National Science Foundation

<http://www.nsf.gov/pubs/2010/nsf10507/nsf10507.htm>

[Home](#)

Meetings Calendar

February 17th-18th, 2010

Spring IAB Meeting

University Of Florida

Gainesville, FL

<http://iucrc.perc.ufl.edu/>

February 28th-March 5th, 2010

PITTCON Conference & Expo

Orange County Convention Center

Orlando, FL

<http://www.pittcon.org/>

February 28th-March 3rd, 2010

2010 SME Annual Meeting

Phoenix Convention Center

Phoenix, AZ

<http://www.smenet.org/>

April 26th-29th, 2010

World Congress on Particle

Technology 2010 (WCPT6)

Exhibition Centre

Nuremberg, Germany

<http://www.wcpt6.org/>

[Home](#)

Do you have comments, questions or suggestions about the PERC e-Newsletter? Email Rodney Guico (rguico@perc.ufl.edu)