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Aeronautical Systems Center
77th AES, ESOH Risk Management Branch (ASC/ENVV)

The Nano Flyer

Keeping the ESOH Acquisition Community Informed on Nanotechnology Developments

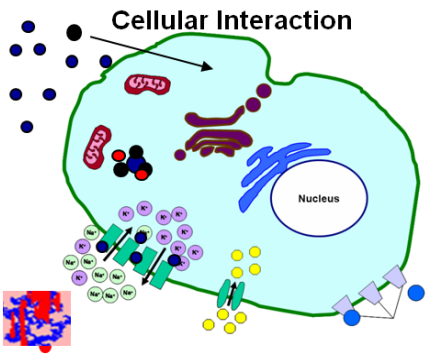
Assessing the Biological Compatibility of Nanoparticles

Nanotechnology research has made significant strides during the past three years leading to a large number of commercial and armed force applications in a short period of time. Health issues and human application issues are of primary concern because of the unusual nature of these particles. The Air Force Research Laboratory nanoscience and nanotechnology enterprise is a leader in studying the interaction of nanoparticles with biological systems. We have learned from past technical breakthroughs that fast advancing technology can rapidly revolutionize current applications; however, the safety in using novel technological applications may be overlooked. One major issue in the area of nanotechnology is the vast number of rapidly emerging applications utilizing different types of nanoparticles or composites. Assessing the interactions of these particles with biological material is limited and a time consuming process to address the toxic effects of a single class of nanoparticles.

Currently, a rapid detection system is not available for assessing the long term genetic, reproductive and developmental effects of such particles. Dr. John Schlager and Dr. Saber Hussain of the 711th Human Performance Wing, Human Effectiveness Directorate at WPAFB and Dr. John Rowe of the University of Dayton formed a collaborative team to develop such a rapid detection system. A detection system being developed at the University of Dayton will act as a screening system for biological samples used in screening the short term, viable, genetic and reproductive effects of nanoparticles, while providing data on the molecular mechanism(s) for observing their interactions. The system involves a tissue culture assessment of genetic and an apoptosis evaluation utilizing specific biomarkers followed by a whole organism study using the fruit fly which can assess genetic, reproductive, developmental and viability effects in a short time span. Another part of the system is bacterial in nature and is presently limited for assessing particles that may be toxic to bacteria. The coupling of the rapid detection system involves linking results from the tissue culture with, for example, double stranded DNA breaks to mutations in a whole organism. Results from bacterial systems are important not only from an ecological point of view but for selectively assessing the toxicity of nanoparticles to bacteria.

The initial study in assessing the biological compatibility of nanoparticles began in the summer of 2007 with the hire of Dr. Mike Goodson, a postdoctoral research associate and three undergraduate students. Dr. John Rowe supervised the entire project at the University of Dayton, with Dr. Mark Nielsen who oversaw the drosophila research, Dr. John Rowe and Dr. Jayne Robinson supervised the microbial studies and Dr. Yiling Hong the tissue culture project. A second postdoctoral research associate, Dr. Maqusood Ahamed was hired in October of 2007 as well as 5 undergraduate students. To date, several presentations and peer-reviewed papers on the toxicity of nanosilver have resulted from the collaboration with AFRL and the University of Dayton; in addition, the EPA/DOE/NSF funded a proposal extending this study until 2010. Currently, the development of a respiratory and development model on the fruit fly and selective toxicity of a number of different nanoparticles on their biological compatibility in bacteria and in tissue culture are in progress. It is expected that the entire detection system will be in place and available for the rapid evaluation through put of nanoparticles by the fall of 2009.

Written by John J. Rowe, PhD,
University of Dayton



F-16 Environmental Working Group (EWG)

The F-16 Environmental Working Group (EWG) was held at Tyndall Air Force Base, Florida on 3-5 February 2009. This yearly meeting was designed to gather information, network with various personnel and present briefings related to environmental issues that impact the F-16 aircraft. There were two specific presentations which dealt with the emergence of nanomaterials on current/ future weapon systems (currently on MERIT's Emerging Contaminant Watch List). The first presentation was on Aeronautical Systems Center's progress related to the Nano Working Group (NWG). Mr. William LaFountain, industrial hygienist from ASC/ENVV briefed Aeronautical Systems Center and Air Force Research Laboratory's current and future plans, policies on nanoscale materials and the Nano Working Group's path forward (briefings are located on ASC's Nano Working Group CoP at https://afkm.wpafb.af.mil/ASPs/CoP/OpenCoP.asp?Filter=MC-AQ-00-95). An industrial perspective was presented by Mr. Roger Brown from AkzoNobel Aerospace Coatings. Mr. Brwon pointed out that AkzoNobel was interested in using nanotechnology based coating/corrosion protection; however the use of nanotechnology is still limited based upon the higher cost and the potential toxicological/ environmental impacts and laboratory tests. All in all, the F-16 EWG offered an excellent forum to present nanotechnology information to a diverse audience that included personnel from Air Force depots, Air Force Plant 4, program offices, and other maintenance operations. The open exchange of information in the F-16 EWG between bases impacted by F-16 operations and the rest of the F-16 environmental community is key to successfully protecting environmental and occupational health while still accomplishing the mission. Next, year's F-16 EWG meeting is tentatively scheduled to be held at Robins Air Force Base. Additional details related to this working group can be obtained by contacting Mr. Paul Hoth, 508 ACSG/ENX, contractor at Paul.Hoth@hill.af.mil or Ms. Mary Wyderski, 313 AESG/SYE at Mary.Wyderski@wpafb.af.mil.

Written by Megan Hawk, SAIC, Tim Sumpter, SAIC, and Marry Wyderski, 313 AESG/SYE

WINGS

Web-Interface Nanotechnology Environmental Safety and Health (ESH) Guidance System

Dr. Saber Hussain, toxicological scientist in the 711th Human Performance Wing, Human Effectiveness Directorate at WPAFB is the principal investigator for the WINGS SBIR program. Dr. Saber Hussain is working with Mr. William LaFountain an industrial hygienist at ASC/ENVV and Mr. Donald Tarazano a contractor for ASC/ENVV to develop a novel Web-Interface Nanotechnology Environmental Safety and Health (ESH) Guidance System (website). Luna Innovations Incorporated

has been selected to develop the WINGS website which will provide Air Force personnel access to tools for managing emerging ESH risks related to the use of nanomaterials including carbonaceous nanomaterials, nanosilver, nanogold and quantum dots. This website will contain a comprehensive safety guidance module, based in part on innovative ESH "best practices" management strategies identified by Luna Innovations Incorporated and the University of Dayton Research Institute (UDRI). UDRI is also working on the framework to address a broad spectrum of issues likely to occur in virtually any Air Force facility where engineered nano-materials are handled. Another member of the team is Intertox, Inc. of Seattle, Washington. Intertox will design risk communication strategies, an employee information program, provide web content on nanomaterial ESH profiles and assist in integrating decision analysis tools. Dr. Michael Kosnett, a consultant is working with the WINGS team to develop guidelines for an occupational health surveillance program using web-enabled information technology. Throughout the program, the team will define and prioritize specific ESH data gaps and fill the gaps through a collection of targeted information and published scientific studies. Luna Innovations Incorporated will integrate the ESH inputs from the team into an easy-to-use web system provided to the Air Force at the completion of the program.

Written by Aaron Small, PhD, Luna Innovations Incorporated

Evaluation of Filtering-Face Piece Respirators

The University of Cincinnati's Center for Health Related Aerosols conducts experiments on various testing methodologies related to the performance of protective face masks. These studies examined both inert and biological aerosols in an ultrafine size range (< 100 nanometers). The initial studies were conducted by Major Robert M. Eninger, PhD, while he was earning his doctoral degree through the Air Force Institute of Technology's Civilian Institutions program. Major Eninger first evaluated a common filter test protocol for its ability to detect the penetration through filters of ultrafine particles.[1] Then, further analysis was performed on various types of personal protective face masks ("known as filtering-face piece respirators"), which are commonly used in medical environments. These studies looked at the penetration of ultrafine particles through the filter material as well as the ability of certain additives to inactivate microbes that pass through the filter.[2,3] Lastly, Major Eninger compared two methods for producing an ultrafine bioaerosol for use in filter testing.[4]

In summary, these studies indicated that filtering-facepiece respirators are effective at filtering ultrafine particles, though specific methods are required to assess filter performance for such a small particle size. The studies resulted in four scholarly journal articles, cited below.

[1]**Eninger, R.M.**, Honda, T., Reponen, T., McKay, R., Grinshpun, S.A. What does respirator certification tell us about filtration of ultrafine particles? (2008) *Journal of occupational and environmental hygiene*, 5 (5), pp. 286-295.

[2]**Eninger, R.M.**, Honda, T., Adhikari, A., Heinonen-Tanski, H., Reponen, T., Grinshpun, S.A. Filter performance of N99 and N95 facepiece respirators against viruses and ultrafine particles (2008) *Annals of Occupational Hygiene*, 52 (5), pp. 385-396.

[3]**Eninger, R.M.,** Adhikari, A., Reponen, T., Grinshpun, S.A. Differentiating between physical and viable penetrations when challenging respirator filters with bioaerosols (2008) *Clean – Soil, Air, Water*, 36 (7), pp. 615-621.

[4]**Eninger, R.M.**, Hogan, C.J., Jr., Biswas, P., Adhikari, A., Reponen, T., Grinshpun, S.A. Electrospray versus nebulization for aerosolization and filter testing with bacteriophage particles (2009) Aerosol Science and Technology, 43 (4), pp. 298-304.

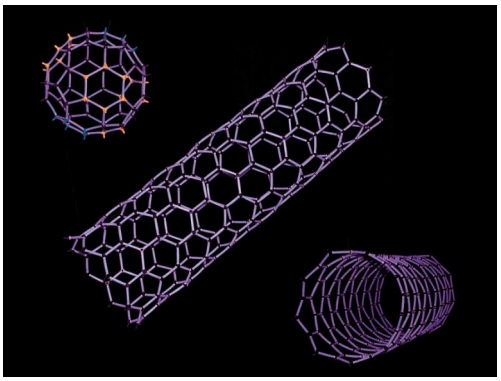


Figure 3: Single Walled Carbon Nanotubes (SWCT) and Carbon Fullerenes (C_{60})

Upcoming Conferences:

2-3 March 2009
Greener Nano 2009
Eugene, Oregon
http://oregonstate.edu/conferences/greenernano2009/

1-2 April 2009
NanoManufacturing Conference & Exhibits 2009
Minneapolis, MN
http://www.sme.org/cgi-bin/get-event.pl?--001784-000007-nhome--SME-

9-11 June 2009
International Conference on the Environmental Implications and Applications of Nanotechnology
University of Massachusetts Amherst
http://www.umass.edu/tei/conferences/nanoconference/index.html

Call for Articles and Information:

Submit articles or suggested topics for inclusion in future bimonthly editions to Megan Hawk at Megan.Hawk@wpafb.af.mil.

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