



## The Asian Workshop on International Collaboration on Nanotechnology Environmental Health & Safety

Co-Sponsored by Rice University/International Council on Nanotechnology and the Nanotechnology Business Creation Initiative

November 30 and December 1, 2006

Mitsubishi Corporation, Mitsubishi (Shoji) Building,  
3-1, Marunouchi 2-Chome, Chiyoda-ku, Tokyo, Japan

A report from Dr. Andrew Harford, Research Fellow, Australian Centre for Human Health Risk Assessment, Monash University, NanoSafe Australia.



Presentations from the workshop can be downloaded from [http://icon.rice.edu/centersandinst/icon/events.cfm?doc\\_id=10005](http://icon.rice.edu/centersandinst/icon/events.cfm?doc_id=10005)

### General Comments

This was an invitation only workshop, which consisted of about 80 delegates from the nanotechnology industry, government agencies and academia. The majority of delegates were from Asia and the USA but there were also a few representatives from Europe and Australia. This workshop was clearly an effort by the International Council on Nanotechnologies (ICON) to reach out into Asia and expand their international scope.

The first day of the workshop comprised presentations from ICON representatives and members of the Japanese nanotoxicology research community. There was also a breakout session to discuss the questions;

- What existing forums or mechanisms are in place to develop and improve best practices for safe nanomaterial handling?
- What efforts should be undertaken to accelerate the development of globally adopted best practices?

The second day involved presentations by delegates from Australia, Taiwan, Singapore and China. The workshop was concluded with a summary of the suggestions raised by the break-out session and discussion concerning the future directions for ICON.

### **Day one**

The workshop began with a presentation from the ICON director, [Dr Kristen Kulinowski](#), and covered the activities of the Center for Biological and Environmental Nanotechnologies (CBEN) and the structure and mission of ICON. Briefly, CBEN has emerged as the leading academic institution conducting research into the biological and environmental impacts of nanotechnologies. This has been due to significant funding from the National Science Foundation (NSF) for the last 5 years. In 2004, CBEN launched ICON, which aims to “*develop and communicate information regarding potential environmental and health risks of nanotechnology to foster risk reduction and maximise societal benefits*”. ICON is a multi-stakeholder council comprising of members from industry, government, academia and non-government organisations (NGOs). It is clearly a significant body with a membership comprising of major players in the field of nanotechnology. However, it was clear by the end of the workshop that ICON had identified a number areas that it needed to strengthen.

The presentation from Dr Kulinowski also informed the delegates of some activities being conducted by their working groups. Of specific interest was;

- Their EHS database (<http://icon.rice.edu/research.cfm>), which aims to be a comprehensive collection of all the research conducted in the field of nanotoxicology.
- A recently document they have produced, i.e. “*A review of current practices in the nanotechnology industry*”, which was presented and discussed at one of the sessions ([http://icon.rice.edu/projects.cfm?doc\\_id=4388](http://icon.rice.edu/projects.cfm?doc_id=4388))
- A project being conducted to assess the EHS research needs for nanotechnology, which was also presented in the following session.

The second presentation was delivered by [Dr. Michael Garner](#) (Intel) and included a summary of the ICON project that is assessing the international EHS research needs for nanotechnology. The project aims to establish a prioritised international EHS research needs document, which is regularly updated and dynamic. To facilitate the project Dr. Garner announced that there will be two workshops next year. The first will be held in January 2007 at the NIH Campus, Bethesda, Maryland and will cover the properties of nanomaterials that need to be considered and their further classification. The second will be later in the year and will include discussions concerning toxicology research needs. The project will undoubtedly be comprehensive and will have a high value to nanotoxicology researchers. However, I questioned how this project could lead to coordinated global research program and also determine who will do the research and who will pay. Unfortunately, my question was beyond the scope of this project and ICON did not appear to know how it will be used once it is produced. It was discussed that ICON does not have a mandate to direct research, however I believe their influence in the field will see this document used in many international forums, which may have a mandate to direct nanotechnology EHS research.

The sessions following a tea-break included a comprehensive overview of the Japanese EHS effort. It began with a presentation by [Dr Masahiro Takemura](#) from the National Institute for Materials Science and included overview of the Japanese strategy and their work to date. The Japanese have been working on these issues for a couple of years and they have conducted a number of workshops and forums on the topic.

The next presentation was by [Dr Takahiro Kobayashi](#) (National Institute for Environmental Studies) and included data from preliminary exposure monitoring studies conducted in nanotechnology workplaces that were producing fullerenes and carbon nanotubes. He reported that the number of nanoparticles in air of workplaces was elevated during work-periods and they were also using scanning electron microscopy to identify the nanomaterials being produced by the facility. Nevertheless, he concluded by stating that further monitoring was required for an appropriate exposure assessment.

[Dr. Junko Nakanishi](#) (National Institute of Advanced Industrial Science and Technology, AIST) presented the Japanese research activities that are addressing the risk assessment and risk management of nanomaterials. The project has funding from the government of \$US 17 million for 5 years and aims to establish the protocols required for a risk assessment of nanomaterials. They will be using classical methods of risk and will target fullerenes, nanotubes and TiO<sub>2</sub> assessment. The project is an impressive multi-disciplinary research program and the audience was only able to get a general overview of the program. I questioned the detail within the program and ask if they have considered chronic and developmental studies. The answer I got was “no” but on further examination of the notes I discovered that they are considering chronic inhalation studies of nanotubes. Nevertheless, I believe there may be a number of gaps within their program that Australian researchers could help with.

The following two presentations were by [Dr. Manabu Shimada](#) (Hiroshima University) and [Dr. Yasuo Morimoto](#) (University of Occupational and Environmental Health). Dr. Shimada presented a system they have developed for the generation of metal oxide (NiO and TiO<sub>2</sub>) nanoparticle aerosols. Interestingly, they showed that not all metal oxide particles of the same composition behaved in the same manner in solution or air. They chose the particles they used based on their ability to generate nano-sized aerosols but were unable to tell me what was fundamentally different about the particles. Nevertheless, their characterisation of the aerosolised nanomaterials was comprehensive. Dr. Morimoto used this aerosol system to expose rats for his inhalation studies. They exposed their animals to NiO and TiO<sub>2</sub> at environmentally relevant doses (i.e. comparable to Dr. Kobayashi’s monitoring results) and measured a number of endpoints such as, body and organ weights, the amount of metal oxide in the lungs, immune cells in blood and lungs, histopathology and gene expression. They found that the exposures resulted in no significant adverse effects and were able to detect NiO and TiO<sub>2</sub> in the lungs of the rats but did not look at translocation to other organs. This was obviously a massive and expensive project but I was left disappointed because the study would had greater value if they were able to determine a dose-response for just one of the nanomaterials or if they had of benchmarked the toxicity of one material against a known nano-toxicant e.g. silica.

The ICON document “*A review of current practices in the nanotechnology industry*” was presented by [Dr. Patricia Holden](#) at the final talk before the break-out sessions. This document can be [downloaded](#) from the ICON website and it represents the first attempt by any group to get a picture of the OHS practices within nanotechnology industries. I can personally appreciate what a large effort went into the project to get a good participation rate for the results. Nevertheless, this presentation created a lively discussion, especially concerning its value and limitations. The general conclusion was that there is a bias within the results due to the methods used in gathering data (e.g. voluntary self reporting by administrators and management) and that there was probably further value that could be extracted from the results (e.g. a profile of industries that were less likely to have good practices).

The break-out sessions followed this presentation and we were split into smaller groups of about 15 to discuss the questions;

- What existing forums or mechanisms are in place to develop and improve best practices for safe nanomaterial handling?
- What efforts should be undertaken to accelerate the development of globally adopted best practices?

ICON has promised to release the list of points generated from these sessions, so I will not go into much detail until this is available. However, for the first question the obvious answers were ISO and OECD forums. For the second question, I contributed by suggesting that if ICON really wanted to accelerate the development of best practices they should advocate that nanomaterials need to be classified as new materials. It was also suggested that more involvement of labour and union representative was required to implement safe practices.

### **Day two**

The second day of the workshop involved contributions from Australian, Taiwanese, Singaporean and Chinese delegates. The session was chaired by [Dr Jurgen Schulte](#) who began with a presentation that described the activities of his Asia-Pacific Nano Forum (APNF). The APNF is a platform that aims to facilitate growth through nanotechnologies and is involved with groups from numerous Asian countries. This presentation highlighted the fledgling strategies of many Asian-Pacific countries but also the lack of activity by in addressing EHS issues surrounding nanotechnologies, including in Australia.

The following presentation was by [Dr. Tsung-Tsan Su](#), (Industrial Technology Research Institute of Taiwan) who presented Taiwan’s “Nanomark” program. I found this a curious presentation because the Nanomark logo is to be granted to efficient nano-products as a marketing tool and assumes that the public will want to buy nano-labelled products. Currently, the nanomark product would not have to pass any EHS standards but it was stated that the program would not provide the stamp of approval to any products with EHS issues. Unfortunately, exactly how this would be determined was not yet known, however the project is aiming to incorporate safety into the protocols at a later stage. It does appear that Taiwan is moving ahead with establishing research programs to address nanotechnology EHS issues. They have also developed a system for generating nanoparticle aerosols for

inhalational studies and are investigating the suitability of standardised *in vitro* and *in vivo* protocols. This presentation concluded with an advertisement for the 3<sup>rd</sup> International Symposium on Nanotechnology, Occupational and Environmental Health, to be held on the 29<sup>th</sup> of August – 1<sup>st</sup> of September 2007 in Taipei, Taiwan.

The presentation by [Dr. Kiang Wee Lim](#), (ASTAR Science and Engineering Council, Singapore) was dominated by nanotechnology development in Singapore and the construction of new infrastructure for nanotechnology research. Limited time was given to Singapore's involvement in the ISO projects and it also appeared that they were in the early stages of developing an EHS strategy, although there were not many details.

In China, there is a coordinated EHS program that is already producing results. [Dr. Chunying Chen](#) (National Center for Nanoscience and Technology, China) reported that China has spent \$US10 million on addressing the issue, which equates to 10% of China's spending on nanotechnologies. It is obvious that China is extremely well equipped to co-ordinate large multi-disciplinary research programs and has the financial capacity to support them. Chinese nanotoxicologists are becoming highly respected in the field and I will be following their output closely.

The workshop was concluded with a presentation from [Georgia Miller](#) (Friends of the Earth, Australia), which focused on the wider environmental, social and political issues of nanotechnologies. She challenged the underlying assumptions of the nano-debate and emphasised that there are more issues to "responsible nanotechnology" than addressing toxicity issues. She also showed that many of fears held by the public do not relate to toxicity issues and stated that nanotechnology management should not solely rely on science-based risk assessments. This was a very well presented and thought-provoking presentation, which concluded by asking ICON to consider all the issues and advocate a precautionary approach.

### **A tour of National Institute of Environmental Studies**

During my time in Japan I was also lucky enough to take a tour of the nanotoxicology facilities at the National Institute of Environmental Studies, Tsukuba. Tsukuba is the scientific centre of Japan and hosts over 150 public and private research institutes. It is 1 hour north of Japan and now easily accessible from Tokyo via the new Tsukuba express line. My gracious host for the day was Dr Takahiro Kobayashi (pictured), who has many years of experience researching ambient air pollution particles. They are heavily involved in researching the health impacts of diesel soot but are currently in the process of setting up additional laboratories for inhalational exposure studies with engineered nanoparticles. They have impressive facilities that are able to characterise a single nanoparticle, monitoring exposure of animals and also have experience in measuring biological endpoints. They are obviously adept at engineering feats and have systems that allow delivery of specific nanoparticle aerosols. I discussed with Dr. Kobayashi the opportunity for collaborations between Australia and Japan and will continue to work with him to develop this.

