Nanoscale Science

Creates Novel Food Systems

IFT's fourth International Food Nanoscience Conference explored advances and applications in nanoscale science, engineering, and technology.

Nanoscale science has the potential to benefit the food industry in ways that range from stabilizing and delivering bioactive compounds in foods to creating new antimicrobial food packaging options. These topics and many others were on the agenda when more than 100 food science professionals assembled in Anaheim for IFT's fourth International Food Nanoscience Conference held June 6, 2009, in conjunction with the Annual Meeting & Food Expo.®

Increasingly, research in food nanoscale science, engineering, and technology shows the potential to impact the sector through the development of new products and the improvement of existing ones, conference presenters explained. Although most of the applications are still in the early stages of development, a few are approaching commercialization, and potential safety concerns and regulatory issues are being addressed.

The conference, which was themed "Nanoscale Science and Technology of Food—From the Lab to the Table," was sponsored by Holland (Netherlands Foreign Investment Agency) and Advanced Foods & Materials Network (AFMNet) of Canada. The event was organized by the IFT Nanoscience Advisory Panel. Here's a look at some of the conference highlights.

Emerging Applications

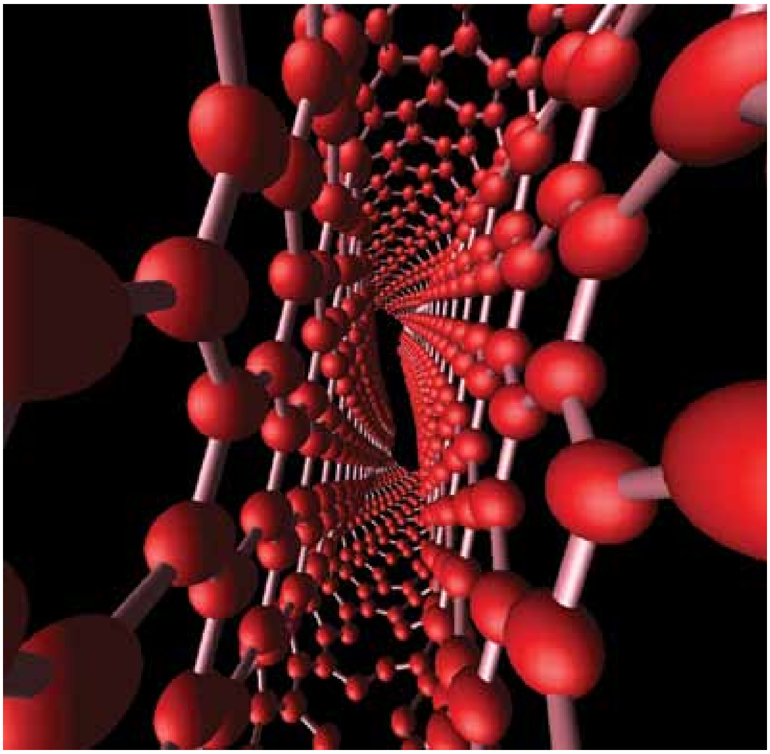
One conference session focused on delivery systems for nutrients and functional compounds in foods. The systems discussed were those adopted mainly from the pharmaceutical industry. They were reported to effectively deliver compounds that are susceptible to degradation processes, such as chemical, biochemical, and microbiological.

Jochen Weiss, Professor, Institute of Food Structure and Functionality at the University of Hohenheim in Germany, discussed edible solid lipid nanoparticles (SLNs) for delivery of bioactives such as lycopene and carotenoids. SLNs are formed by controlled crystallization of food nanoemulsions and range in size between 50 and 500 nm. Size is influenced by nucleation and crystal growth processes, which are determined by the initial drop size and the composition of the interfacial membrane that stabilizes the droplet.

The major advantages of SLNs include large-scale production without the use of organic solvents, high concentration of functional compounds in the system, long-term stability, and the ability to be spray dried into powder form. Challenges to production include dispersion of the functional compound within the lipid and polymorphic transformation due to loss of fluidity.

In another session, Cristina Sabliov, Assistant Professor in the Department of Biological and Agricultural Engineering at Louisiana State University, focused on polymeric nanoparticles for controlled release and targeted delivery of functional compounds. They are made using polymers and surfactants.

Edible polymer types, including alginic acid, polylactic-co-glycolic acid, and chitosan, are used in her laboratory. Sabliov presented data on polymeric nanoparticles, including vitamin E, itraconazole (an antimicrobial), and β-carotene as a



View from within a twisted carbon nanotube. Image copyright Vin Crespi, Penn State Physics. Distributed under the Creative Commons license (http://creativecommons.org/licenses/by-sa/2.5/)

colorant. Synthesis methodologies, composition, and particle properties, such as size and morphology, were described for each nanoparticle. Further research is needed to establish optimum release conditions and body uptake in the case of vitamin E.

Where Is the Nano in Food?

In a different approach to nanotechnology in food, José Miguel Aguilera, Professor at the Department of Chemical and Bioprocess Engineering at P. Universidad Católica de Chile, outlined the natural and unintentional sources of nanotechnology in food. He cited examples of natural events that may result in formation of nanoscale materials or employ nanoscience principles.

Examples included digestion of food and food structure building processes such as the arrangement of amylose and amylopectin in a starch granule. A cow's udder was given as an example of a nano device for synthesizing, assembling, and dispensing proteins and fat at the nanoscale level. Similarly, processes that cause microstructural changes in food, such as homogenization and fine milling, may likely result in nanoscale particle formation.

Concluding, Aguilera reiterated the importance of the current knowledge and tools derived from nanoscience in understanding the role of nanotechnology in food.

Nanotechnology Regulation

Annette McCarthy of the Office of Food Additive Safety at the Center for Food Safety and Applied Nutrition provided an update on U.S. regulation of nanotechnology in food. She assured the audience of the FDA's sufficient authority in assessing the safety of nanomaterials.

The FDA does not currently have a specific definition for nanotechnology, thus regulatory assessments are based not only on material size but also on their impact on identity and toxicity. McCarthy mentioned that the FDA is in the process of developing product safety guidance documents to be used by industry. In the meantime, she emphasized the need for close collaboration between industry members and the FDA to exercise responsible development of the technologies.

IFT and Nanoscience

Bernadene Magnuson, Senior Scientific and Regulatory Consultant with Cantox Health Sciences International and a member of the IFT Nanoscience Advisory Panel, discussed IFT's Food Nanoscience initiatives, including educational activities such as conferences and workshops, responses to various government agency position statements, and publications in IFT journals. These activities have established IFT as a leader and catalyst for research, innovation, and communication in this field. More details can be obtained on the IFT nanotechnology Web site at http://www.ift.org/cm.

Applications Showcased

Three technologies were highlighted in a session dedicated to current commercial and near-commercial applications. They included the *NutraLease* technology for delivery of additives and bioactive compounds, nanostructured iron compounds for food fortification, and antimicrobial coatings for food packaging applications.

NutraLease is a joint venture between Hebrew University of Jerusalem (technology developer) and Frutarom (marketer). Nissim Garti, a Professor at the Casali Institute of Applied Chemistry at Hebrew University discussed the *NutraLease* technology, which consists of nanosized, self-assembled liquid vehicles (NSSL) for delivery of nutrients and bioactives. NSSLs are novel, nano-based emulsions that are highly soluble and fully dilutable in aqueous phase. Vehicles for several compounds such as omega-3 fatty acids, carotenoids (lycopene, lutein, astaxanthin), CoQ10, phytosterols, and isoflavones have been developed and patented. They have been used successfully in clear beverages without phase separation or cloudiness. NSSL-based products are currently marketed world-wide by Frutarom and in the United States via PL Thomas.

Food fortification has been identified as a key process for resolving micronutrient deficiency, especially in developing regions of the world. For example, iron fortification has been used to successfully address iron deficiency complications. However, many of the iron sources of choice for use in food fortification are not readily bioavailable due to low solubility. The highly bioavailable sources such as ferrous sulfate cause quality problems in foods, such as undesirable changes in color and taste.

According to Florentine Hilty of the Laboratory for Human Nutrition at the Swiss Federal Institute of Technology (ETH) in Switzerland, nanosizing iron compounds helps alleviate their bioavailability as observed through in vitro and animal studies. Additionally, the nanostructured compounds minimize undesirable quality changes in the final product. Size reduction is achieved using flame spray pyrolysis.

Other compounds, such as zinc, have also been shown to have improved bioavailability. Further research is needed in the areas of safety and shelf-life stability to fully understand the benefits of the nanostructures.

Bill Norwood, President of nanoAgri Systems Inc., discussed the company's process that uses nanotechnology and chemistry to develop a system for production of antimicrobial coatings for packaging. The technology is based on an open-air flame technique for coating packages and is targeted to the fruit and vegetable industry.

It consists of a machine coupled to a specialized device known as nanomiser, which is used to convert antimicrobial solutions into fine (nanosize) droplets. The droplets are combusted by the flame into

NanoCell-Q* from *Metagenics *was commercialized using* NutraLease's *patented NSSL (Nano-sized Self-assembled Structured Lipid) technology.* Photo courtesy of NutraLease

vapor that coats the package. *Salmonella*, *Listeria* and *Escherichia coli* showed delayed growth when the technology was tested. A portable version of the machine has recently been developed. Commercialization of the technology is pending approval by regulatory agencies.

Lessons From Nonfood Industries

Anne Chaka, Senior Research Scientist at the National Institute of Standards and Technology (NIST), outlined important properties enabled through nanotechnology by highlighting the opportunities and challenges faced by the nonfood sector. She also discussed how the food industry could benefit by learning from their experiences.

Among the sectors highlighted were medical/pharmaceutical, electronics, aerospace, automotive, chemical, and forestry. Although some of these sectors are high-value, the challenges faced cut across all industries and all boundaries. Hence, global cross-disciplinary collaborative efforts are needed.

Chaka encouraged the food industry to join the NIST Cross-Industry Alliance to facilitate close collaboration to identify common challenges and solutions. Chaka also discussed the role of NIST as a standards-setting organization. NIST supports the industries through development of new standards, standard reference materials, and measurement technologies/metrology among other products and services. Several reference materials have already been developed, including gold (10, 30, and 60 nm) and polystyrene (60 nm). Others, such as single-walled carbon nanotubes and titanium dioxide, are in developmental stages.

In conclusion, it is evident from the Nanoscience Conference presentations that nanotechnology offers potentially great benefits to the food industry. Current research, especially in the area of product safety, will help reveal the full benefits of these technologies. Furthermore, development of a conducive regulatory environment will strengthen further research and streamline the commercialization process. The food industry can draw lessons from other sectors that are advanced in nanotechnology research, development, and commercialization. Overall, there is a need for increased collaboration among researchers, regulators, and manufacturers to overcome the challenges and to fully realize nanotechnology's benefits. **FT**

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