Nanotechnology in the food industry: applications, opportunities and challenges

Global Food Safety
Solutions for Today and Tomorrow

24 October 2012
Nano, nano everywhere!

David Hawxhurst
Woodrow Wilson International Center for Scholars
Outline

- Brief History
- Definitions
- Regulatory Issues
- Advancing Technologies
- Applications
  - Food Packaging
  - Food Safety - Sensors
  - Delivery/Release
  - Nutraceuticals

- AFMNet Examples
- Education
- Consumer/public Issues
- Adoption
Word is relatively new but the concept is not

- Creation of the word/field is relatively “new”
  - Richard Feynman 1959 talk “There’s Plenty of Room at the Bottom” - "nano-scale" machines
  - Nori Taniguchi 1974 “Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule.”

**On the Basic Concept of 'Nano-Technology**


- Concept is old:

The Lycurgus Cup (Rome) is an example of dichroic glass; colloidal gold and silver in the glass allow it to look opaque green when lit from outside but translucent red when light shines through the inside.

http://www.nano.gov/nanotech-101/timeline

Richard Smalley discovered the Buckminsterfullerene (C60), more commonly known as the buckyball, which is a molecule resembling a soccerball in shape and composed entirely of carbon, as are graphite and diamond.

http://www.nano.gov/nanotech-101/timeline
Nano – on the nm lengthscale

The invocation of the 1 nm -100 nm dimension scale is essentially ubiquitous:

- International Organization for Standardization
- European Commission
- Environmental Protection Agency (U.S.A.)
- European Scientific Committee on Consumer Products
- Health Canada
- National Nanotechnology Initiative (U.S.A.)
- National Cancer Institute (U.S.A.)
- American National Standards Institute
Defining Nanotech

- Two principal parts to defining what is to be considered nanotechnology:
  - (i) **Scale** and (ii) **Uniqueness/novelty**

- Nanotechnology is the understanding and control of matter:
  - (i) → … at dimensions between approximately 1 nm to 100 nm
  - (ii) → … where unique phenomena enable novel applications
Nanotechnology Definition
(Fall 2011)
The European Commission - Natural, etc., 50%

→ altered its recommended definition of nanotechnology (for regulatory purposes) to focus on particle size alone


COMMISSION RECOMMENDATION of 18 October 2011 on the definition of nanomaterial (Text with European Economic Area (EEA) relevance) (2011/696/EU)

HAS ADOPTED THIS RECOMMENDATION

‘Nanomaterial’ means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm-100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness the number size distribution threshold of 50 % may be replaced by a threshold between 1 and 50 %.

When talking about nanoscience/technology are all objects/particles synthesized?

- NO!!

http://www.foodscience.uoguelph.ca/deicon/casein.html
Does nano exist in foods? Yes!

Source: Rogers et al., 2008

Fat crystal network

SEM Chocolate

CryoSEM Whipped cream

TEM Yogurt

Courtesy of Dr. P. Braun (Buhler)

TEM Emulsion O/W

TEM Amylose gel

AFM amylose

http://www.ifr.ac.uk/spm/glucoamylase.html

Hermansson, 2008
Nanotechnology Definition
(Summer 2011)
U.S. Food and Drug Administration – Engineered, limits

Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology
Guidance for Industry
DRAFT GUIDANCE

This guidance document is being distributed for comment purposes only.
U.S. Department of Health and Human Services
Food and Drug Administration
Office of the Commissioner
June 2011

At this time, when considering whether an FDA-regulated product contains nanomaterials or otherwise involves the application of nanotechnology, FDA will ask:

1. Whether an engineered material or end product has at least one dimension in the nanoscale range (approximately 1 nm to 100 nm); or
2. Whether an engineered material or end product exhibits properties or phenomena, including physical or chemical properties or biological effects, that are attributable to its dimension(s), even if these dimensions fall outside the nanoscale range, up to one micrometer.

These considerations apply not only to new products, but also may apply when manufacturing changes alter the dimensions, properties, or effects of an FDA-regulated product or any of its components. Additionally, they are subject to change in the future as new information becomes available, and to refinement in future product-specific guidance documents.

http://www.fda.gov/RegulatoryInformation/Guidances/ucm257698.htm
Policy Statement on Health Canada's Working Definition for Nanomaterial

Health Canada's Working Definition of Nanomaterial
Health Canada considers any manufactured substance or product and any component material, ingredient, device, or structure to be nanomaterial if:

1. It is at or within the nanoscale in at least one external dimension, or has internal or surface structure at the nanoscale, or;
2. It is smaller or larger than the nanoscale in all dimensions and exhibits one or more nanoscale properties/phenomena.

For the purposes of this definition:

1. The term "nanoscale" means 1 to 100 nanometres, inclusive;
2. The term "nanoscale properties/phenomena" means properties which are attributable to size and their effects; these properties are distinguishable from the chemical or physical properties of individual atoms, individual molecules and bulk material; and,
3. The term "manufactured" includes engineering processes and the control of matter.

This version 2 was approved and posted on the Health Canada website on October 6, 2011.

Helping the public understand nanotechnology

http://www.understandingnano.com/introduction.html

http://www.umt.edu/ethics/debatingscienceresourcecenter/nanotechnology/NanoODC/default.aspx
Evolution of Nanoscale Science and Technology

- The evolution has largely paralleled development of instruments and tools

Figure 1: 1986-Invention of AFM, image from Mike Tiner, [http://www.cnm.utexas.edu/AFM.HTM](http://www.cnm.utexas.edu/AFM.HTM)

Figure 2: 1981-Invention of STM, Image From Steven Sibener, [http://sibener-group.uchicago.edu/facilities.html](http://sibener-group.uchicago.edu/facilities.html)
Nano in Agri-Food

NEW PESTICIDES
TARGETED GENETIC ENGINEERING
IDENTITY PRESERVATION
AGRICHEMICAL DELIVERY
SENSORS TO MONITOR SOIL CONDITIONS

NANOENCAPSULATION OF FLAVORS/AROMAS
GELATION AND VISCOSIFYING AGENTS
NANOEMULSIONS
ANTICAKING
SANITATION OF EQUIPMENT

NUTRACEUTICALS
NUTRIENT DELIVERY
MINERAL AND VITAMIN FORTIFICATION
DRINKING WATER PURIFICATION
SENSORY CHARACTERISTICS OF SUPPLEMENTS

UV PROTECTION
ANTIMICROBIALS
CONDITION AND ABUSE MONITORS
HIGH BARRIER PLASTICS
SECURITY/ANTICOUNTERFEITING
CONTAMINANT SENSORS

### Nano-products currently identified on the market

<table>
<thead>
<tr>
<th>Company</th>
<th>Product Name</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tip Top®</td>
<td>Tip Top UP® Omega-3 DHA</td>
<td>Fortified with nanocapsules containing Omega-3 DHA rich tuna fish oil</td>
</tr>
<tr>
<td>Shemen industries</td>
<td>Canola Activa oil</td>
<td>fortified with nonesterified phytosterols encapsulated via a new nanoencapsulation technology (NSSL: Nano-sized self assembled liquid structures, developed by Nutralease (Israel) for optimising the absorption and bioavailability of target nutrients</td>
</tr>
<tr>
<td>RBC Life Sciences®, Inc.</td>
<td>Nanoceuticals™ Slim Shake Chocolate</td>
<td>nanoscale ingredients that scavenge more free radicals, increase hydration, balance the body’s pH, reduce lactic acid during exercise, reduce the surface tension of foods and supplements to increase wetness and absorption of nutrients</td>
</tr>
<tr>
<td>Shenzhen Become Industry &amp; Trade Co., Ltd.</td>
<td>Nanotea</td>
<td>Nano-fine powder produced using nanotechnologies.</td>
</tr>
<tr>
<td>Aquanova</td>
<td>NovaSOL Sustain</td>
<td>nano-carrier that introduces CoQ10 to address fat reduction and alpha-lipoic acid for satiety</td>
</tr>
</tbody>
</table>

(adapted from “The project on emerging nanotechnologies”, 2009)
Nano – Food Packaging

Under development:
- Non-sticking, non-wetting surfaces based on lotus-leaf effect - biomimicry.
- “Smart” Packaging:
  - Goal is to optimize product shelf-life and safety.
  - Bioactive materials and/or nanosensors incorporated into the packaging material.
  - Responds to environmental conditions (e.g., temperature or moisture changes).
  - Alerts consumer if food is contaminated.
  - Detects pathogens and releases antimicrobial agents.
Antimicrobial Surfaces

- Surfaces with nano-silver coating
  - e.g., kitchenware, tableware, cutting boards, refrigerators, etc.

Antibacterial Kitchenware

Company: Nano Care Technology, Ltd.

Product Web Site

What They Say

“Antibacterial tableware and kitchen tools Tableware and kitchen tools play an important role in people’s daily life. It is also one of the most usual ways to spread disease especially in public places like restaurant, cafes, and inns, etc. People always use traditional ways such as sterilizer to kill bacteria and germs but the result is not satisfied, because many bacteria and viruses survive or relive very quickly.

Our Antibacterial tableware which with nano silver coating could kill the attached bacteria and microbial in ten minutes and the effect can last for a long time even permanently and keep the surface always clean. Thus, our antibacterial tableware and kitchen tools can prevent people from the following diseases: duodenitis caused by spirillum, virosis hepatitis, dysentery caused by salmonella and food poisoning caused by golden staphylococcus.”

(www.nanotechproject.org)
Food Safety

- **~2 million** people die annually from diarrhoeal diseases, largely attributed to contaminated food and water.

- Nanosensors could detect the presence of microbial contamination.
  - less cumbersome, more portable instrumentation with increased sensitivity and reduced detection time, and require less technical training of personnel necessary to conduct pathogen detection.
Nano-Sensors

- Potential Applications:
  - Pathogen detection (bacteria, viruses)
  - Toxin and pesticide detection
  - Spoilage detection
  - Authenticity and traceability
  - Quality control
Nano-Sensors

- The nanocantilever can be coated in antibodies against the specific pathogen to be detected such that when a contaminant lands on the device, it can be rapidly detected and measured.

Atomic Force Cantilever

artsci.ucla.edu/BlueMorph/researchAFM.html

E. coli bacteria www.marlerblog.com/E_coli_lge.jpg

An artist's depiction shows an atomic force microscope probe (not to scale) 'fishing' for molecular sites recognized by an antibody tethered to the probe by a fine polymer thread. The new technique promises to vastly improve the capabilities of atomic force microscopy.

www.innovations-report.com/.../report-32458.html
Portable SERS (surface enhanced Raman spectroscopy) Sensor for Sensitive Detection of Food-Borne Pathogens

- Novel assay comprising Nanoplex™ biotags, magnetic beads, and a prototype portable Raman spectrometer
- Rapid and simultaneous detection of enteric food-borne bacterial pathogens
- Escherichia coli O157:H7
- Salmonella species
- Good analytical sensitivity, accuracy, and specificity
- Minimal level of operator intervention and training required to achieve exquisitely sensitive DNA detection
- Point-of-care, on-site food quality diagnostics, or field GMO testing

Nano-Sensors

- UV activated, oxygen sensitive, colored ink based on titanium dioxide.
- Changes color in presence/absence of oxygen.

*Photographs of oxygen indicator ink printed on a MAPed food package. Left: Before UV activation. Middle: After UV activation. Right: On opening the package. (Photographs: David Hazafy, University of Strathclyde)*
Selective Determination of Catechin among Phenolic Antioxidants with the Use of a Novel Optical Fiber Reflectance Sensor Based on Indophenol Dye Formation on Nano-sized TiO$_2$

- Optical sensor for *tea catechins*; quantitative measurements
- Traditional *health claims* for tea (vasodialation, coronary heart disease prevention, and diuretic, antioxidant, anticholesterol, anti-inflammatory, antibacterial, antiviral, anticancer, and antineurodegenerative effects) are mostly due to tea catechins
- Immobilized 2,2′-(1,4-phenylenedivinylene)bis-8-hydroxyquinoline (PBHQ) on TiO$_2$ nanoparticles
- “indophenol blue” dye formation on PBHQ-immobilized TiO$_2$
  \[ \rightarrow p\text{-aminophenol (PAP)} \text{ autoxidation with dissolved O}_2 \]
- Among quercetin, rutin, naringenin, naringin, gallic acid, caffeic acid, ferulic acid, *p*-coumaric acid, catechin, epicatechin, epicatechin gallate, epigallocatechin, epigallocatechin gallate, and trolox, **only catechin** group antioxidants delayed the color formation on nanoparticles
Nanoencapsulation - nanoemulsions

- Functional ingredients are essential components in many foods
  - e.g., vitamins, colours, flavours, preservatives, antimicrobials, etc.
- Usually need some sort of delivery system to optimize activity.
- Payload substantially decreased
Nanoencapsulation - nanoemulsions

- A number of potential advantages of using nanoemulsions rather than conventional emulsions for this purpose:
  - Carry the ingredient to the desired site of action
  - Control the release of the ingredient (e.g., release rate) in response to an external trigger (e.g., pH, temperature, ionic strength, enzymes, etc.)
  - Greatly increase the bioavailability of lipophilic substances
  - Scatter light weakly and so can be incorporated into optically transparent products
  - Can be used to modulate the product texture
  - A high stability to particle aggregation and gravitational separation
  - Protect the ingredient from chemical or biological degradation
  - Must be compatible with the food attributes (e.g., appearance, texture, taste/flavour)

Casein nanoparticles as nano-vehicles

- **Casein micelles**
  - Nano-capsules created by nature to deliver nutrients (calcium, phosphate, protein) to the neonate
  - Natural self-assembly tendency of bovine caseins
  - Morphology and average diameter of re-assembled micelles similar to those naturally occurring
  - Useful nano-vehicles for entrapment, protection and delivery of sensitive hydrophobic nutraceuticals within food products, e.g., vitamin D2

Milk protein nanotubes

Fig. 1. (Left) Schematic presentation of the self-assembly of partially hydrolysed α-lactalbumin into nanotubes in presence of Ca\textsuperscript{2+}. (Right) Transmission electron micrograph of negatively stained α-lactalbumin nanotubes (negative staining was performed with 3% uranyl acetate for 1 min).
Finding added value in a traditional waste stream – chitosan nanoparticles for vitamins

Trimethyl chitosan–Tripolyphosphate nanoparticles:
- Smallest (196 nm) obtained from the combination of the lowest TMC and TPP ratio
- Incorporation of vitamins C, B9 and B12 into nanoparticles confirmed
- Cooperative effect of negatively charged groups and the anion tripolyphosphate favored the nanoparticle size increasing, as observed for vitamins C and B9 encapsulation

Trimethyl chitosan–Tripolyphosphate nanoparticles with two different magnifications: (a,b) 10,000× and (c,d) 20,000×.
Proteins from corn - zein

- Zein ultra-fine fibres
  - Gallic acid incorporated (5%, 10% and 20%)
  - To develop an encapsulating technology for functional ingredient delivery using electrospinning
  - Fibre diameters 327 to 387 nm

SEM and TEM images of gallic acid loaded zein electrospun fibres with varying gallic acid content: (a) 25 wt.% zein solution (0% gallic acid); (b) 5% gallic acid; (c) 10% gallic acid and (d) 20% gallic acid (w/w in solid fibres), respectively. The images on the right of each panel show the TEM illustrations of gallic acid loaded zein electrospun fibres at 100 nm scale bar.

Encapsulation using seaweed

(a) Curcumin encapsulated in a well-oriented and crystalline fiber of iota-carrageenan
(b) Cross-section of a complex assembly containing ordered curcumin molecules (red star) in the iota-carrageenan network -- blue, green and red = iota-carrageenan double helix; pink circles = cations
(c) Curcumin molecules securely trapped between a pair of helices; cations (black), water molecules (green) and sulfate groups (red and blue).

**Nano heating for containers**

- Efficient → battery power made possible
- Portable → lunch boxes, camping, vending machines, plates, cups, bowls...
- Food safety and quality → temperature control, fresh cooking in portable container

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|----------------------|---------------------------|

**Abstract**

Embodiments involve a food warmer that uses a nano thickness heating material as the heating element. The heating element has a fast response and is energy efficient. The temperature of the food warmer can be precisely controlled. The food warmer may be used to heat cold food to a desired temperature, maintain a temperature of already heated food, and/or cool uncooked food.

**References Cited**

<table>
<thead>
<tr>
<th>Reference Type</th>
<th>Patent No.</th>
<th>Date</th>
</tr>
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**FORUM PATENT DOCUMENTS**


**OTHER PUBLICATIONS**

JP 07-241246 A. Machine translations of Description and Drawing key.*

**Primary Examiner** — Joseph M. Pelham

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**Inventors:** Geng Li, Hong Kong (CN); Joey Cho Yee Chow, Hong Kong (CN); Chih Lin L. Hong Kong (CN); Edward S. Yang, Hong Kong (CN)

**Assignee:** Advanced Materials Enterprises Company Limited, Hong Kong (UK)

**Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 800 days.

This patent is subject to a terminal disclaimer.
Examples of nanoscale research projects – Advanced Foods and Materials Canada www.afmcanada.ca/

- Bacteria, Biofilms and Foods: Nanotechnology-Based Approaches to Understanding Bacterial Contamination of Foods and Food Processing Surfaces
- Biopolymer Based Controlled Release Systems for Biomedical Applications
- Engineering the Oil Binding Capacity and Rheological Properties of Nanocrystalline Fat Networks Structured using High Shear Fields under Non-Isothermal Conditions
- Nutrigenomic and Formulation Studies with Folates and Reduced Folates
- Salt, Science and Society: A Collaborative Approach to Salt Reduction in Processed Foods
- The Traceability and Authenticity of Foods from Analytical and Consumer Perspectives
- Manufacture of High Performance Renewable Fibres from Hagfish Slime Thread
- Advancing the Platform Technology of Polysaccharide Nanoparticles through Development of Value Added Industrial Products
Salt, science and society: A collaborative approach to salt reduction in processed foods

Collaborative multi-disciplinary multi-institutional research project:

Rousseau (Ryerson, PL), Nickerson (Sask), Paulson (Dal), Mazzanti (Dal), Pink (St.FX.), El-Sohemy (UofT), Duizer (Guelph), Hensen (Guelph)

General Mills, Agropur, Canadian Stroke Network
Despite health concerns, it’s still hard to resist!

KFC Double Down = 1,740 mg Sodium
McDonald’s Big Mac = 1,020 mg Sodium
Burger King’s Whopper = 970 mg Sodium

Recommended Daily Intake = 1200-1500 mg Sodium
Carrier specifications

- Stable carriers to survive processing conditions
- Capsule breakdown in mouth (pH 7)
- Food grade ingredients
- Both burst and prolonged release
- Nanometer to micrometer size range
Bio-molecular carriers

- **Double emulsions (W/O/W)**
  - Inner phase comprised of nano-sized droplets w/ NaCl.
  - Liquid foods - soups

- **Biopolymer-based nanoparticles**
  - pH-sensitive protein-polysaccharide carriers
  - Proprietary polysaccharide carriers
  - Solid foods – cheese
Problems with iron fortification

- Unpleasant taste and color
- Instability, precipitation
- Toxicity, nausea, vomiting, poor appetite, diarrhea and constipation
- Poor bio-availability
New product Fe
(ave size 0.3 µm)

Ferric pyrophosphate
(ave size 5.2µm)

Particle Size (µm)

Distribution Density (Q3/g)

Laser diffraction particle counter
Supersonic wave: 2 min.
Stability of Iron Sources

5 mg Fe / 100 ml, pH 7.0, stored at 40°C under dark conditions
Storage time: Nano Fe for 3 months, all others 2 days
STUDY: YOU THOUGHT YOU ORDERED SEA BASS

Fishy business

You say tuna, I say tilapia: DNA testing shows that one-quarter of fish is mislabeled

BY REBECCA DUBE

Before you bite into that fish and chips or spend $50 on halibut at the supermarket, you may want to take a second look: 25 per cent of fish is mislabelled, according to a University of Guelph study published today that used DNA analysis to determine the true identity of fish sold in Toronto and New York.

One sample sold as tuna turned out to be tilapia, halibut was really hake; and red snapper was, on different occasions, lavender jobfish, Labrador redfish, perch and cod.

“There’s not a lot of regulation around fin fish; it’s basically been ignored,” says study co-author Robert Hanner, associate director for the Canadian Barcode of Life Network and an assistant professor of biology at the University of Guelph.

“Now that we have the tool to do it, we probably have an obligation to start testing.”

He and co-author Eugene Wong tested 96 samples of fish from grocery stores, markets and restaurants in New York and Toronto. They analyzed the DNA of each fish and compared it with a global database of species. They intended simply to test the database, which performed well, identifying each piece of fish they found. Discovering so much fish fraud was a surprise.

“Says ‘FISH’ PAGE 3

PHOTO ILLUSTRATION/THE GLOBE AND MAIL
Issues – moving forward

- Many potential benefits but must also identify any potential risks
- Various governments/agencies are in the process of developing policies/regulations
- Need to educate consumers/public to avoid a repeat of the discussion involving Genetically Modified Organisms
Educating the public, especially the young

http://www.nanooze.org/english/nanooze_newsletters.html
http://nanoyou.eu/
Nanotechnology Programs at Universities

- Developing area
- Programs must include social sciences, e.g., ethics, consumer attitude
- Should we develop such programs? Should we emphasize first principles?
U of G to Offer Canada's First Nanoscience Major
September 19, 2007 - News Release

The University of Guelph is thinking big about the "very small" with a pioneering undergraduate nanoscience major to begin on campus next year. It will be Canada's first full-fledged nanoscience major.

Nanoscience involves developing materials on the scale of individual atoms and molecules, typically less than about 100 nanometres in size. In such a miniature world, materials display special — even counterintuitive — electrical and chemical properties.

They are being explored by companies eager to make new devices and products in such areas as computing and microelectronics, biotechnology, energy, toxicology and medicine.

"It's moved very quickly from the realm of the science lab to the very first commercial products," said chemistry professor Dan Thomas, associate dean of Guelph's B.Sc. program, who studies nano-scale properties of materials and substances.

Other universities currently offer nanoscience courses within chemistry, physics and engineering programs, but no other school offers a degree program. U of G's new interdisciplinary major will be jointly provided by the departments of chemistry and physics and will draw on research and teaching strengths in those and related departments,

Consumer/Public Issues

What are some of the issues consumers/public concerned about?
- Transparency and inclusivity
- Fear of the unknown
- Can we guarantee zero risk?
- Is science static?
Consumer/public issues

Do environmental attitudes and food technology neophobia affect perceptions of the benefits of nanotechnology?

YES! The level of food technology neophobia held is significant in explaining not only opposition to the use of nanotechnology in food packaging and food applications but also opposition to the use of nanotechnology in general.

Matin, AH (2012) Do environmental attitudes and food technology neophobia affect perceptions of the benefits of nanotechnology?, Int. J. consumer studies, 36, 149 -157
Consumers suspicious of nanotech, irradiation and cloning

By Rory Harrington, 05-Mar-2010

Nanotechnology and Its Impact on Consumers

The Issue

The emergence of nanotechnology as one of the key advances of this century promises consumers significant benefits. However, many nanomaterials are new to commercial use and their requirements for safe use and management are not known. Consumer confidence in the safety and efficacy of product applications of nanotechnology will be necessary to achieve market acceptance necessary to recoup the costs of development and make nanotechnology-based products successful.

The properties of nano-scale materials bring certain risks. These tiny materials can be more chemically reactive and exhibit very different electrical, physical, optical and magnetic properties than their larger counterparts. In addition, nanomaterials may be more toxic, and may be disposed of in the environment, not just during manufacture, use, disposal, recycling or nontreated direct release.

Considerable uncertainty exists about the actual risks posed, because information is limited on the potential toxicity of nanomaterials and the actual exposure to the nanomaterials and the actual exposure to the life cycle of the product. Regulatory and oversight policies and priorities in Canada are in their early stages. Regulations face many challenges that make it difficult to draft appropriate regulations – lack of scientific data, definitions, test procedures and instrumentation to identify and assess the materials, the number and diversity of products being developed, and the difficulty in keeping up with the rapid development of products.

We particularly note the following for policy-makers when evaluating future regulations:

- Concerns have arisen about who will control the development of the technology and who will benefit from it, how it will affect an individual's privacy, and how it will be used to enhance human capabilities.
- Policy makers must find the right balance between consumer protection demands of safer products and nanomaterials.孱

How much do consumers really know about nanotechnology?

‘Better safe than sorry’: consumer perceptions of and deliberations on nanotechnologies

**Conclusion**: “…today's consumers are generally ill informed about its nature and its applications in consumer-related products.”

Are you aware of the debates around nanotechnology?
Tell us how much you know about this emerging technology

guardian.co.uk, Wednesday 25 May 2011 16.19 BST

This poll is now closed
What influence does the product have on consumer attitude?

- Food vs Non-food
Would you be happy to use a suntan cream if it contained a nanomaterial?

guardian.co.uk, Thursday 7 July 2011 11.12 BST

76.3% Yes
23.7% No

This poll is now closed
How have NGOs responded to nanomaterials’ potential toxic effects?

Many non-governmental organizations have reacted against the rapid introduction of nanomaterials in the market. They ask questions about potential toxic effects and advise authorities to apply new approaches (Oct ’19)

Related Articles

Uncertainties surrounding nanoparticles aimed for medical use

Picked for you on this topic

Nanotechnology Brings Personalized Therapy One Step Closer to Reality

Non-governmental organizations around the world share concern for finding nanomaterials with potential harmful effects in stores. Research shows different nanomaterials cause injuries to animal models and it is unclear what the effects would be on humans. These organizations have developed different policies to deal with the problem.

David Santillo is a scientist at Greenpeace Research Laboratories who has worked for more than 15 years developing environmental protection policies. “Greenpeace policy on nanotechnology is to apply a precautionary approach. This doesn’t mean that we are necessarily opposed to all research and development of nanomaterials, before they are released into the market,” he said. “Regulators’ discussions have been hampered by disagreements about the definition of nanomaterials. Nonetheless, rather than developing regulation in parallel with nanotechnology, the technology has been forced ahead. Nano can mean a lot of different things. There are for example particles, tubes, fibers and sheets formed from different compounds that could all have properties distinct from bulk forms of the same materials. Carbon nanotubes can bear similarity to asbestos, but the complexity of nanotubes is that not all appear to have asbestos-like properties. What transformations can take place and what changes will we see over time in the physical and chemical nature of nanomaterials, which are used in products and may be released to the environment? Those are questions that people do not have answers to. In developing the technologies and products of the future, the focus should be on trying to find the most sustainable solutions, whether or not nanotechnology has a role to play,” he said.

In Section Toxicology

Could nanoparticles in cosmetics be toxic?

Nanoparticles in our cities: are there any risks for our health?

How have NGOs responded to nanomaterials’ potential toxic effects?

Dr. Ndeke Musee: “To protect our environment we need to understand nanotechnology risks because today’s nanoproducts will be tomorrow’s waste streams”

http://www.youris.com/Nano/Toxicology/How_Have_NGOs_Responded_To_Nanomaterials_Potential_Toxic_Effectskl
Consumers, nanotechnology and responsibilities operationalizing the risk society.

By H Throne-Holst – Dissertation to obtain the degree of doctor at the University of Twente April 2012

How do consumers respond to emerging nanotechnologies realizing that they live in a risk society?


April 25th, 2012 | Category: Ethical aspects of nanotechnologies, Formation/ information in nanotechnology, Ne3ls analyse, Results of search, scientific-papers, Strategic intelligence
January 2012: FDA sued for lack of regulation of existing products on the market

1. This is an action for declaratory and injunctive relief regarding the failure by the Food and Drug Administration ("FDA" or "the agency") to respond within a reasonable time to a petition filed by the International Center for Technology Assessment, Friends of the Earth, The Action Group on Erosion, Technology and Concentration, and The Center for Environmental Health (collectively, "Petitioners") for rulemaking requesting that FDA regulate nanotechnology products under its statutory purview, including but not limited to sunscreen drug products composed of manufactured nanomaterials. Petitioners are joined by Food and Water Watch and The Institute for Agriculture and Trade Policy (collectively "Plaintiffs") in this action.

2. Nanotechnology is a powerful new set of technologies for observing, taking apart and reconstructing nature at the atomic and molecular level. Consumer products containing manufactured nanoparticles have already arrived on market shelves, and numerous products that fall under FDA’s jurisdiction, like nano-cosmetics and nano-sunscreens, are now widely available. Manufactured nanomaterials have fundamentally different properties from their bulk material counterparts—properties that also create unique human health and environmental risks—which necessitate new health and safety testing paradigms. Yet FDA has failed to address the risks of nanomaterials.
Science, Philosophy Debates

- Is the debate around nanotechnology similar to the debate around genetically modified organisms (GMO)?
Religious beliefs and public attitudes toward nanotechnology in Europe and the United States

Dietram A. Scheufele, Elizabeth A. Corley, Tsung-jen Shih, Kajsa E. Dainty and Shirley S. Ho

How do citizens make sense of nanotechnology as more applications reach the market and the mainstream media start to debate the potential risks and benefits of technology? As with many other political and scientific issues, citizens rely on cognitive shortcuts or heuristics to make sense of issues for which they have low levels of knowledge. These heuristics can include predispositional factors, such as ideological beliefs or value systems, and also short-term frames of reference provided by the media or other sources of information. Recent research suggests that 'religious filters' are an important heuristic for scientific issues in general, and nanotechnology in particular. A religious filter is more than a simple correlation between religiosity and attitudes toward science; it refers to a link between benefit perceptions and attitudes that varies depending on respondents' levels of religiosity. In surveys, seeing the benefits of nanotechnology is consistently linked to more positive attitudes about nanotechnology among less religious respondents, with this effect being significantly weaker for more religious respondents. For this study, we have combined public opinion surveys in the United States with Eurobarometer surveys about public attitudes toward nanotechnology in Europe to compare the influence of religious beliefs on attitudes towards nanotechnology in the United States and Europe. Our results show that respondents in the United States were significantly less likely to agree that nanotechnology is morally acceptable than respondents in many European countries. These moral views correlated directly with aggregate levels of religiosity in each country, even after controlling for national research productivity and measures of science performance for high-school students.
'Better safe than sorry': consumer perceptions of and deliberations on nanotechnologies

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Abstract

Although nanotechnologies are considered key technologies that can drive growth-generating innovations in well-saturated markets, worldwide investment in nanotechnologies has to date focused largely on technology-related development programmes and little effort has been expended to research associated risks. As a result, even though prior discourses have sensitized western consumers to potential health-related dangers, solid knowledge on, for example, the toxicological and eco-toxicological risks and unintended side effects of nanotechnology are scarce. This paper therefore presents an overview of the current evidence on consumer knowledge and perceptions of nanotechnology and public engagement with it, with a focus on the US, the UK and Germany. Overall, even though survey data suggest that awareness of the term “nanotechnology” has risen slightly, today’s consumers are generally ill informed about its nature and its applications in consumer-related products. Hence, based on our analysis of these data, we argue that early political engagement in the nanotechnology issue – for example, consumer policy options that support consumer interest in the marketing of ‘nanos’ – would facilitate objective public discourse.
Focus

Public perceptions of nanotechnology

Focus issue: Feb 2009 Volume 4, No 2

• Editorial
• News & Views
• Letters
• Thesis
• From the archives

Research into public perceptions of nanotechnology is becoming more rigorous with social scientists developing and testing increasingly complex theoretical models. This is demonstrated by three papers in the February 2009 issue of Nature Nanotechnology that explore how the public's reaction to nanotechnology depends on cultural predispositions, religiosity and the specific application of the new technology. These papers confirm that increased public awareness of nanotechnology will not, on its own, automatically lead to widespread public acceptance.

Editorial

Getting to know the public p71

http://www.nature.com/nnano/focus/public_perceptions.html
Adoption of science and technology at the nanoscale level - steps must be taken

- Transparency.
- Education – public, children
- Benefits must be clearly articulated
- Potential risks must also be clearly articulated. Food safety, risk assessment and risk management
- Environmental aspects

Dr. Berna Magnuson
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Some nanofood for thought

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