Bio-nanotechnology for Food: Challenges in Nanotechnology for Wageningen

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Nanotechnology in the life sciences

February 13	13:30	Pieter Stroeve (UC Davis)- Size, measurement and sensing
	14:30	Mieke Kleijn (WUR)- Surface forces using AFM
February 20	13:30	Pieter Stroeve- (Bio)materials
	14:30	Ernst Sudholter (WUR)- Hybrid organic semiconductor FETs
February 27	13:30	Pieter Stroeve- Self assembling molecular structures
	14:30	Richard Schasfoort (U Twente)- Surface modification and microfabrication strategies
Friday, March 5	13:30	Pieter Stroeve- Environment
	14:30	Keurentje (TU Eindhoven)- Micellar systems for nanoscale engineering of reaction and separation processes
Friday, March 12	13:30	Pieter Stroeve- Life sciences and medicine
	14:30	Ton Visser (WUR)- Single-molecule fluorescence in microfluidic devices

Challenges in Nanotechnology for Wageningen

Nanotechnology: A New Frontier in Food Science

Understanding the special properties of materials of nanometer size will allow food scientists to design new, healthier, tastier, and safer foods.

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Nanotechnology: A New Frontier in Food Science

FOODTECHNOLOGY

DECEMBER 2003 • VOL. 57, NO. 12

Understanding the special properties of materials of nanometer size will allow food scientists to design new, healthier, tastier, and safer foods.

Carmen I. Moraru, Chithra P. Panchapakesan, Qingrong Huang, Paul Takhistov, Sean Liu, and Jozef L. Kokini

Nanotechnology—the science and technology that focuses on special properties of a material which emerge from nanometer size—is becoming one of the most promising scientific fields of

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ELSEVIER

Current Opinion in Colloid and Interface Science 8 (2003) 346–348

Current Opinion in COLLOID and INTERFACE SCIENCE

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Editorial overview

Food Colloids … Drifting into the Age of Nanoscience

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Challenges in Nanotechnology for Wageningen

Symposium: New Technologies for Nutrition Research

New Technologies for Nutrition Research[1]

Sharon A. Ross,*[2] Pothur R. Srinivas,[†] Andrew J. Clifford,** Stephen C. Lee,[‡]
Martin A. Philbert,[††] and Robert L. Hettich[‡‡]

KEY WORDS: • *bioactive food components* • *food science*
• *nanotechnology* • *proteomics*

Challenges in Nanotechnology

- Materials
  - gels - nanoparticles - biocolloids
  - cells - emulsions - membranes - composites
- Product development
  - formulation - texture - nutrition
  - stability - taste - color - smell
- Processing (on the nanoscale)
  - nano science - synthesis - kinetics
  - reaction engineering - thermodynamics - transport processes
- Nano-sensing
  - process control - monitoring - detection
- Measurement and Characterization
  - AFM - FFM - surface characterization
- Food Safety
  - contamination - health effects of nanoparticles

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Why Bio-nanotechnology at WUR?

- Existing expertise
- Proximity to agriculture and food processing industry
- Off-campus research centers institutes
- History in research on value-added foods
- WUR leadership

Benefits to WUR, Industry, and the Netherlands

- Increase visibility
- Obtain extramural funding
- Attract talented students and professionals
- Train students
- Expand into new research programs
- Stay competitive
- Develop improved research and teaching facilities for bio-nanotechnology
- Enhance student-faculty-industry interactions
- Facilitate public outreach

Challenges in Nanotechnology for Wageningen

from Moraru et al., 2003

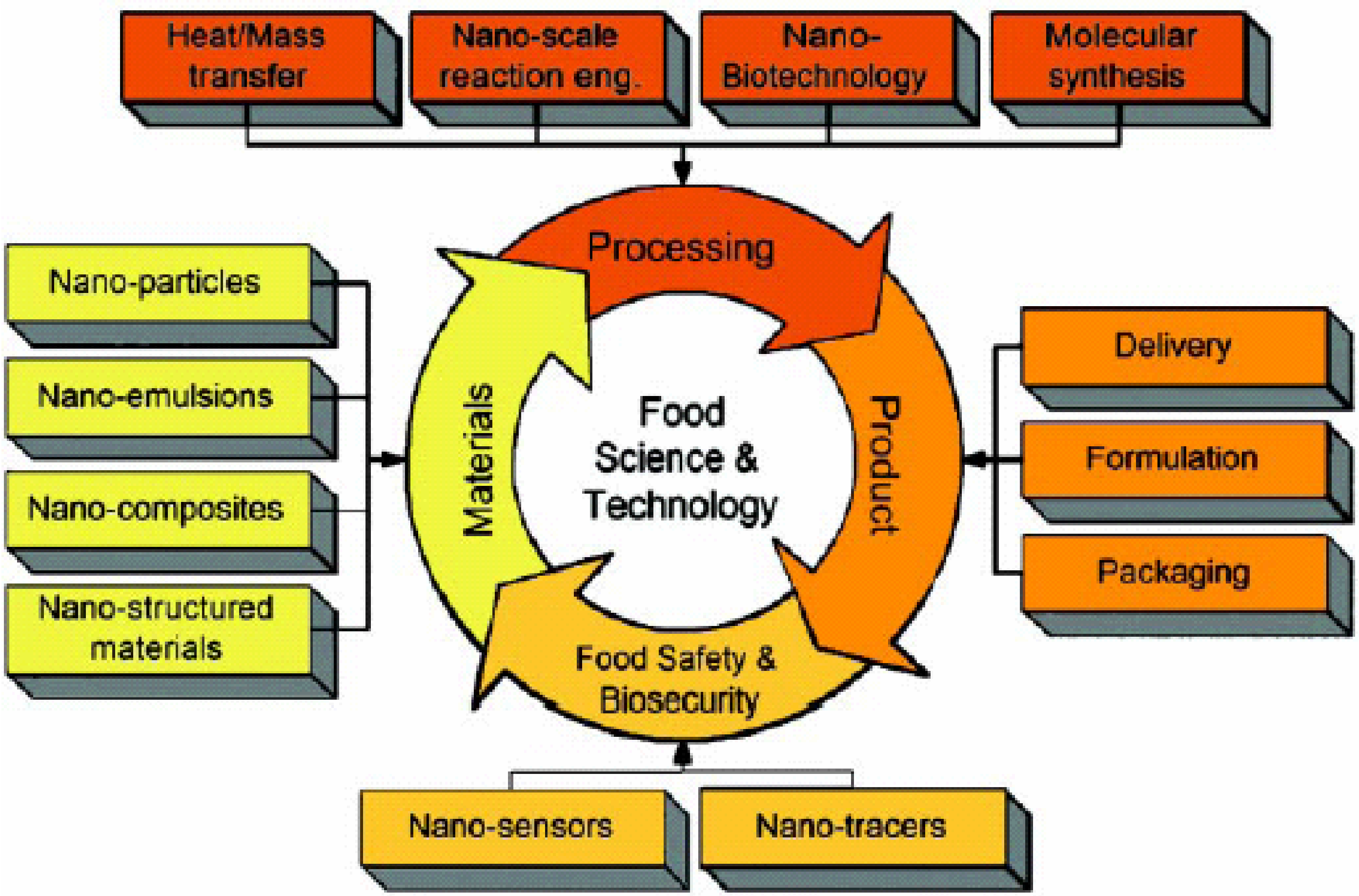

Fig. 1—Application matrix of nanotechnology in food science and technology.

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Challenges in Nanotechnology
Development of new food products

- Delivery systems for biologically active materials
  - delivery of flavors
  - neutraceuticals
- Utilization of complex phase behavior
  - texture   - taste
  - appearance   - color
- Bio supramolecular assemblies
  - internal barriers
  - change of properties

Materials

Fibers: Protein gels

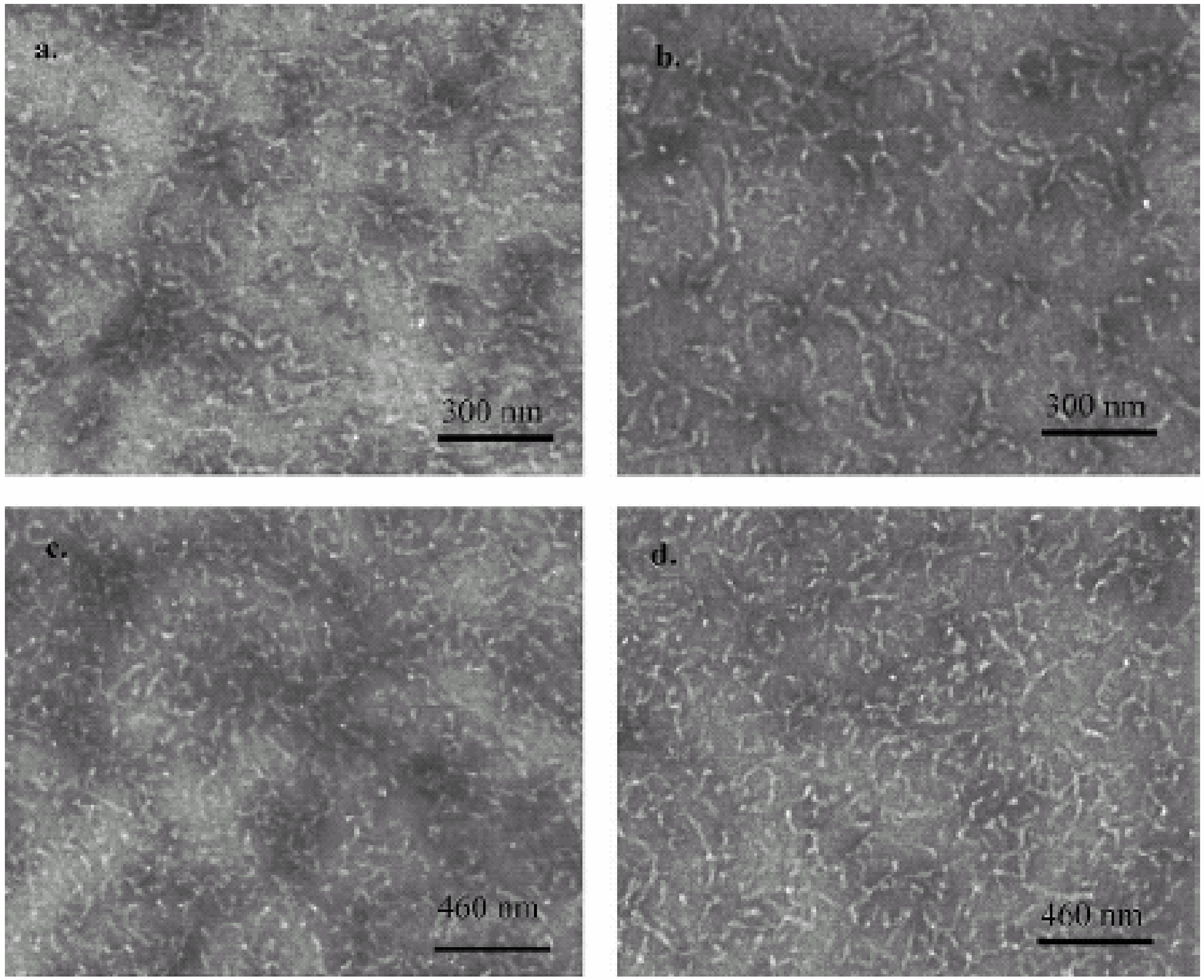

Fig. 4. TEM micrographs of 7% ovalbumin at pH 2 and 0.01 M ionic strength, for various times after dilution: (a) 0 min; (b) 10 min; (c) 105 min; (d) 24 h.

Materials

van Aken et al., Curr. Op. Coll. Interf. Sci., 2003

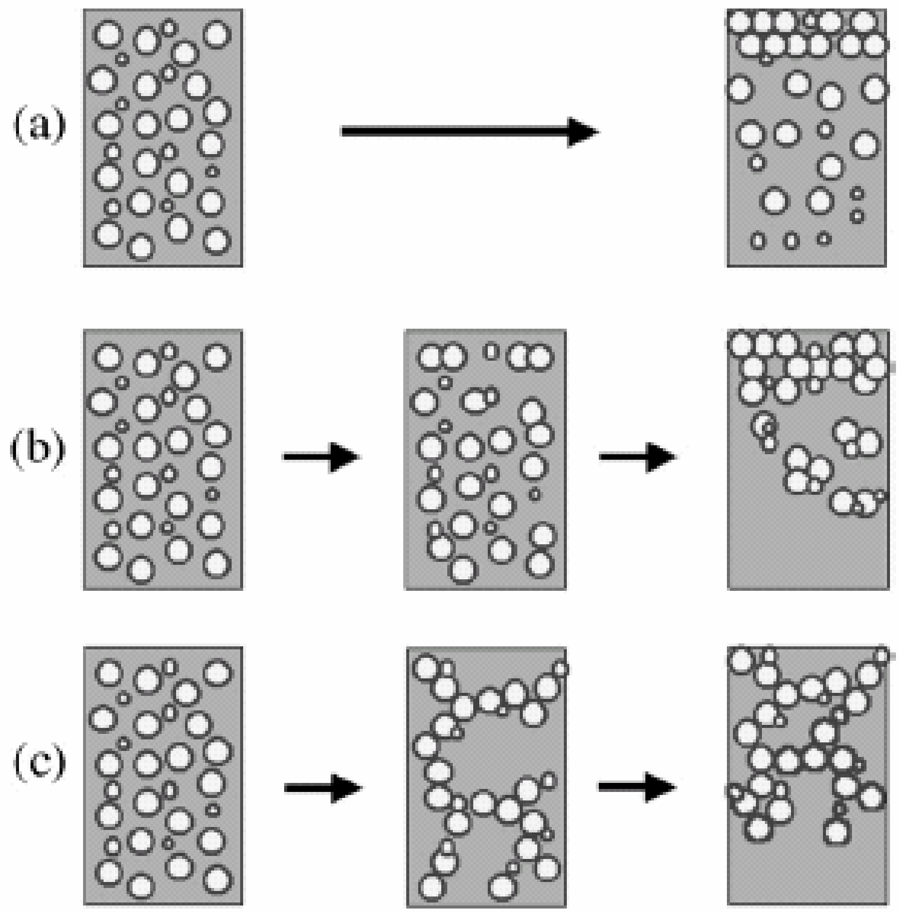

Fig. 1. Structural evolution of oil-in-water emulsions for different aggregation-to-creaming rate ratios. A: aggregation rate ≪ creaming rate: creaming of single droplets. B: aggregation rate ≈ creaming rate: (accelerated) creaming of discrete aggregates. C: aggregation rate ≫ creaming rate: formation of an emulsion-gel network that contracts due to gravity.

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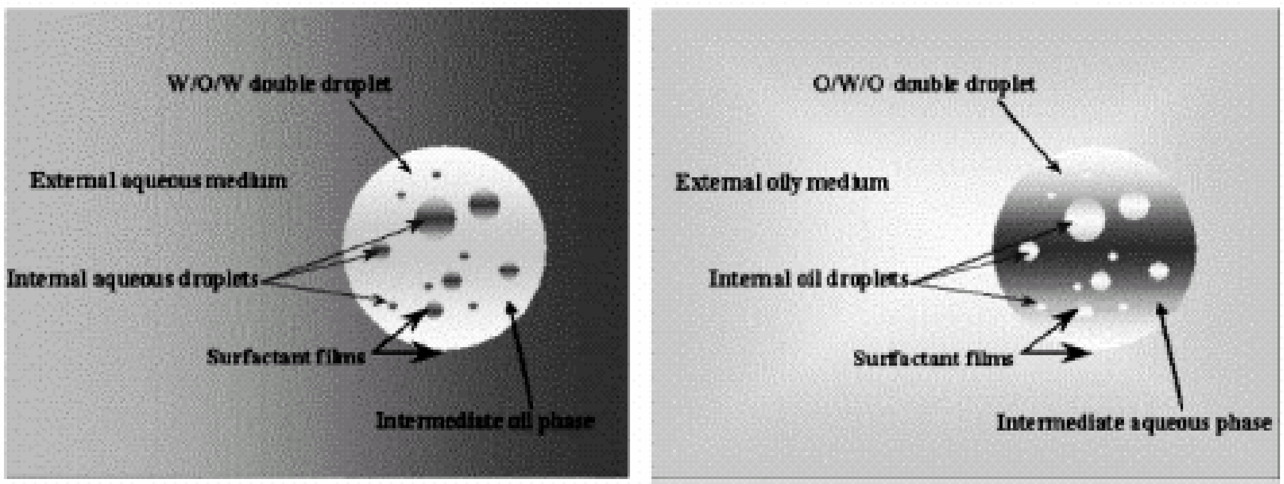
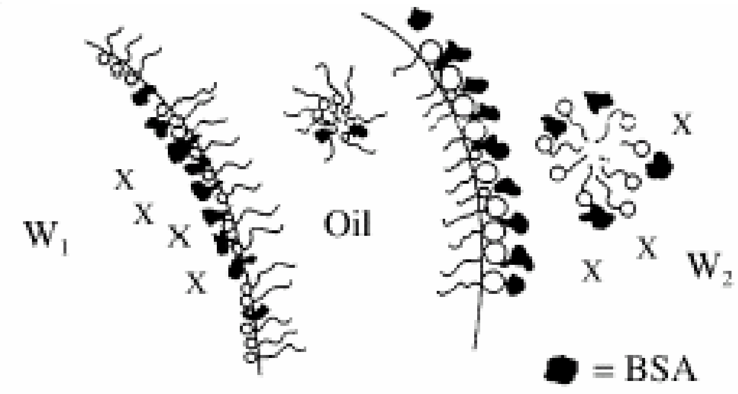
Materials

Double emulsions

A. Benichou et al. / Advances in Colloid and Interface Science 108–109 (2004) 29–41





Processing on the nanoscale

separations

from Hatton et al., 2003

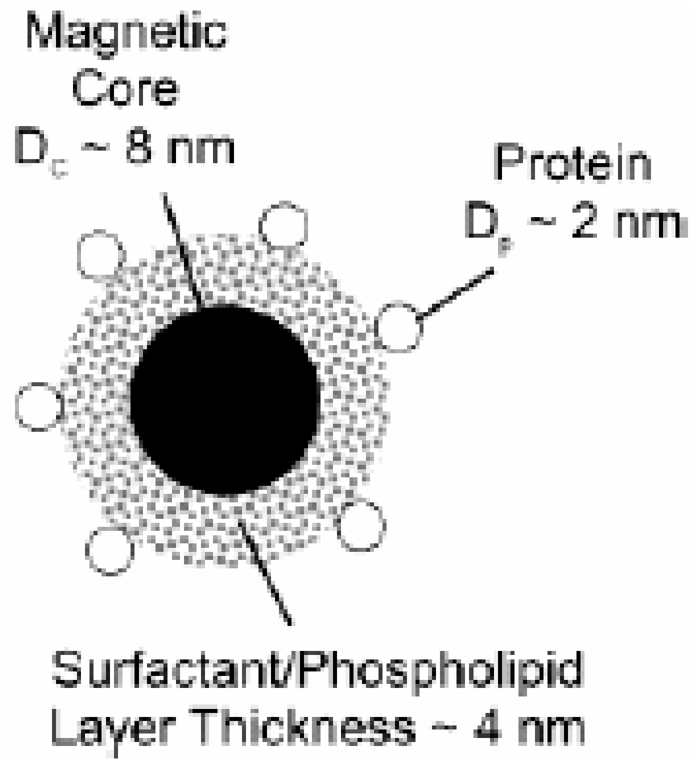
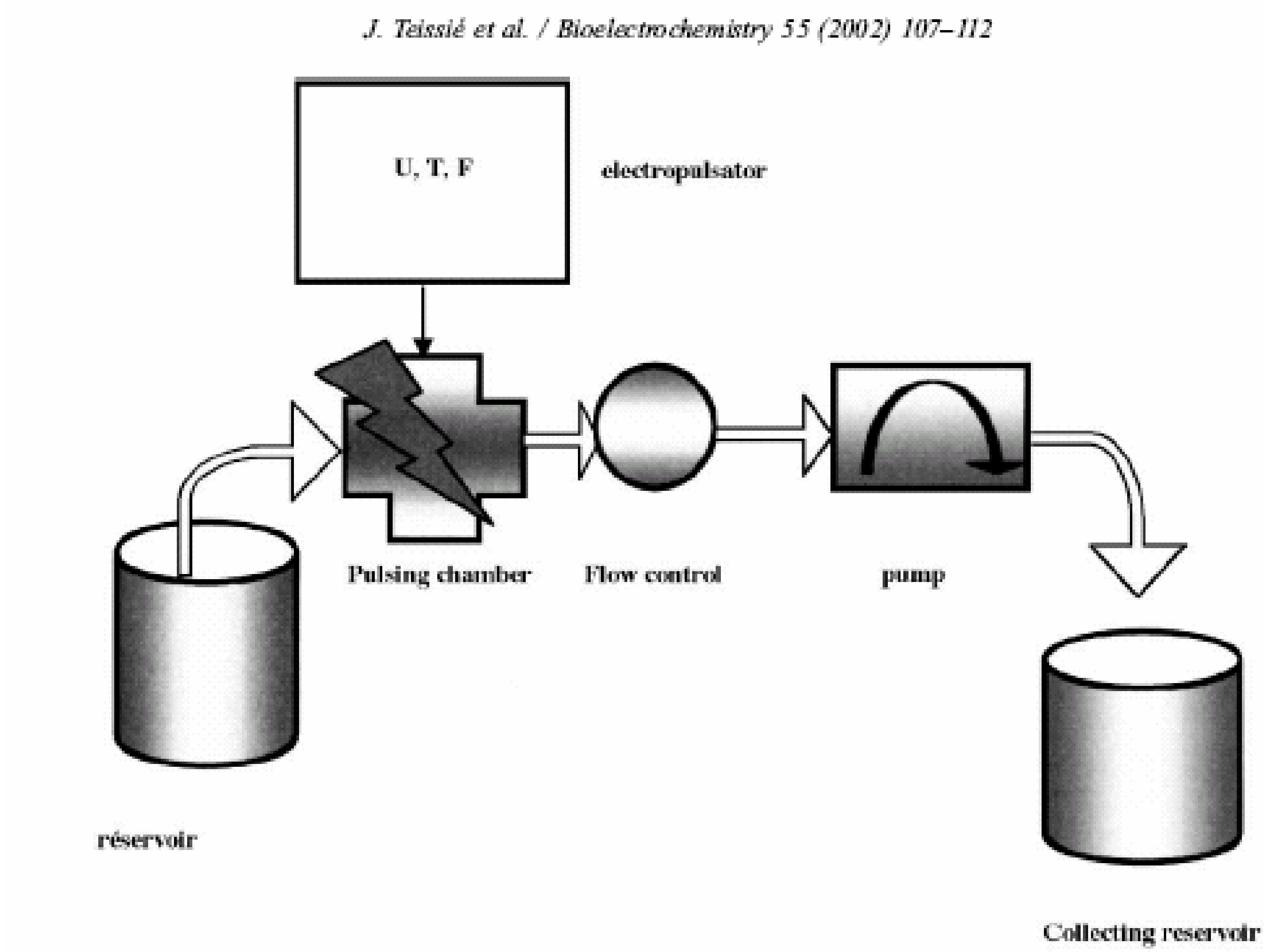
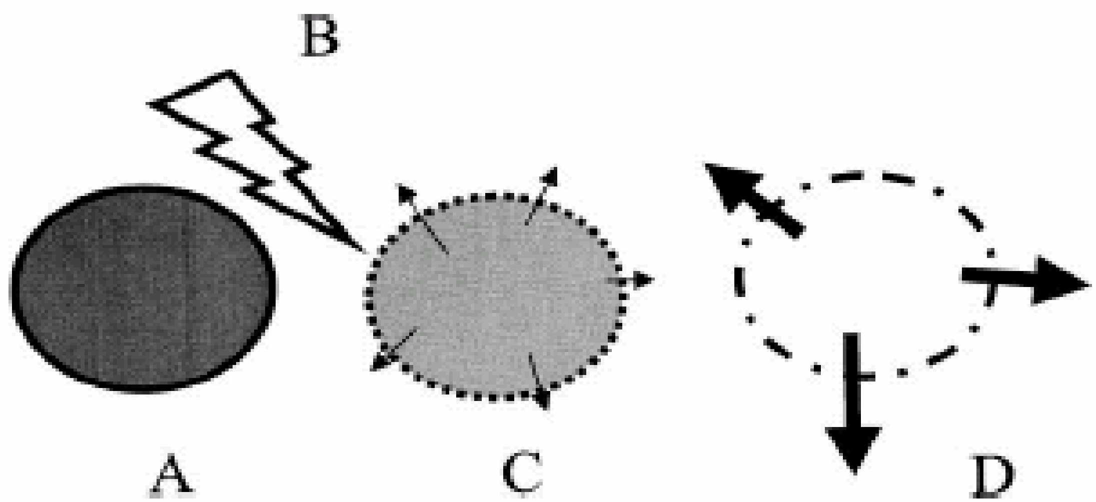


Figure 3. Schematic illustration of a coated magnetic nano-particle showing the relative sizes of the particle core, lipid coating and adsorbed protein.

Processing on the nanoscale
electropulsation



Processing on the nanoscale: electropulsation



Fošnarič et al.

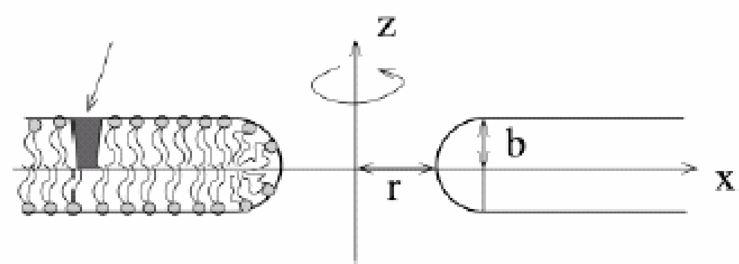


Figure 1. A planar lipid bilayer with a pore in the center. The figure shows the cross-section in the $x-z$ plane. Rotational symmetry around the z-axis is indicated. On the left side, the packing of the lipid molecules is shown schematically. The headgroups of lipid molecules are represented by filled circles. The arrow denotes the membrane inclusion, which is shown schematically.

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Nano-sensing

- toxins in food, proteins, water
- viruses
- bacteria
- pollutants in water
- bioprocess monitoring
  - process control
- biochemicals
- intracellular activity
- sensors on foods for tracking

Measurement and characterization

AFM

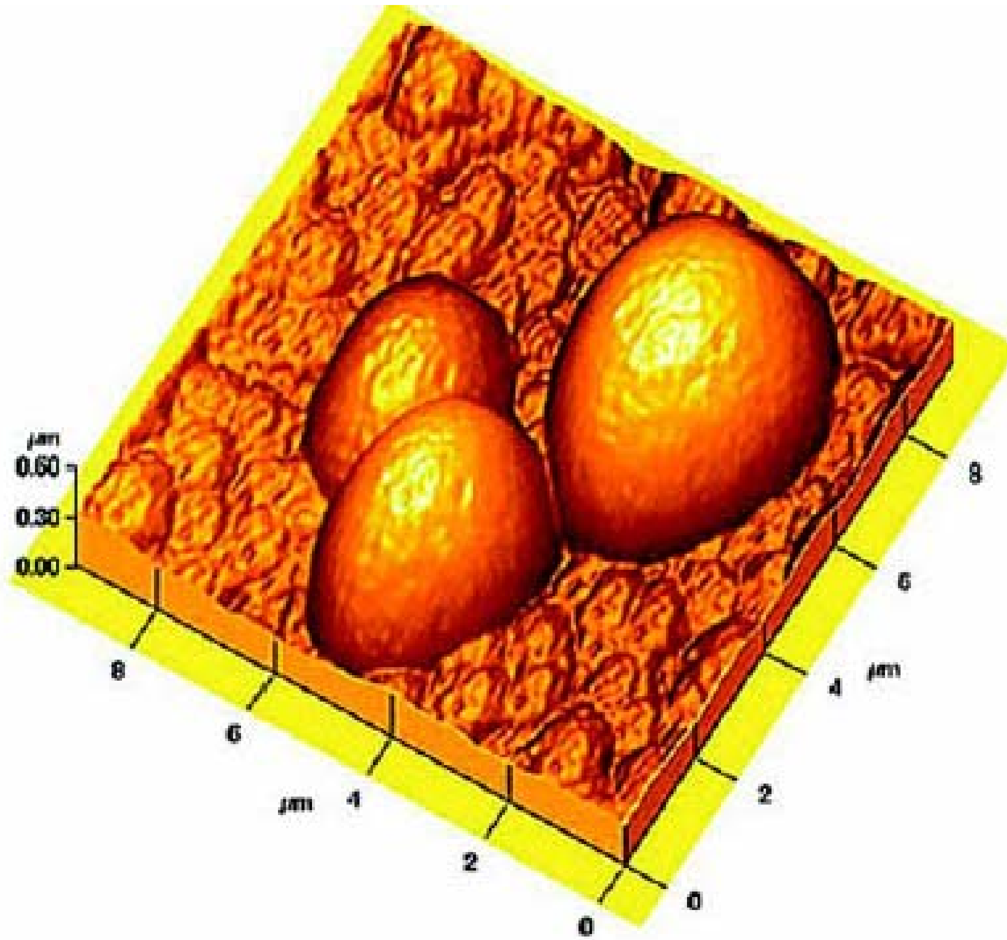


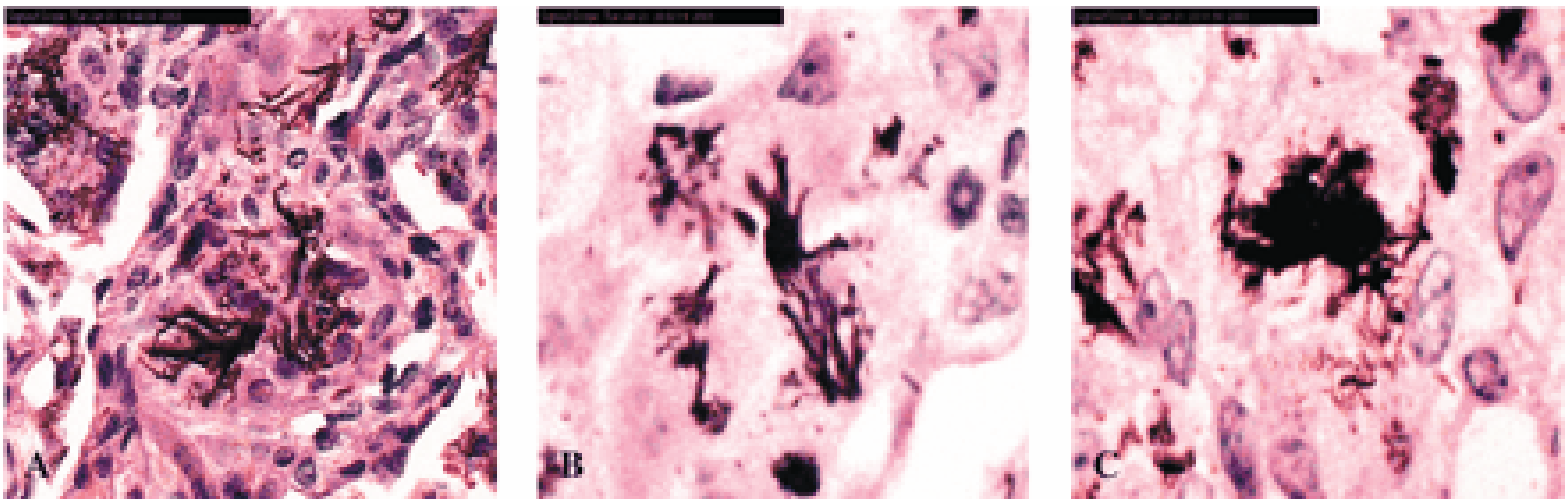
Fig. 4—Surface topography of triticale starch granules. From Juszczak (2003).

Pulmonary toxicology of SWCNT

health effects of nanoparticles

Lung tissues from mice instilled with 0.5 mg of SWCNT per mouse and euthanized 90 d after the single treatment showing presence of fibers. (A) Raw fibers in a granuloma. (B) Purified fibers in a granulomas. (C) Purified clumps of fibers in a granuloma (Magnification 900x).

C.W. Lam et al., Tox. Sci., 2004



Challenges in Nanotechnology for Wageningen

- Fundamentals of supermacromolecular and colloidal structures
- Complex phase behavior in biocolloids
- Development of new food products
- Fundamentals of food processing on the nanoscale
- Characterization of food nanostructures
- Measurement and prediction of food properties
- Nanocomposite materials
- Developing nanosensors for biochemicals, toxins, monitoring, etc.
- Food safety