Trends in Micro- & Nanoencapsulation Research

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UAB-CEI's 1st Workshop on Nanomedicine
Outline

1. Encapsulation
2. Micro- and nanoencapsulation at the ICN
Outline

1. Encapsulation

2. Micro- and nanoencapsulation at the ICN
Encapsulation

Technology of **packaging** micro- or nanoparticles of **solid**, **liquid** or **gas**, also known as the **core** or active, within a secondary material, named as the **matrix** or **shell**, to form **nano- or microcapsules**.

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**Nanoparticles**  **Microparticles**  **Visible particles**

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<th>0</th>
<th>1µm</th>
<th>1000 µm</th>
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**Capsules size**
### Micro- and nanocapsules

**Core or Active:**
- Hydrophobic liquids
- Aqueous solutions
- Solids
- Emulsions
- Dispersions
- Gas

**Shell:**
- **Polymers**
  - **Natural:** polysaccharides (agar, alginate, pectin, proteins (gelatin, albumin))
  - **Synthetic:** polyamides, polyesters, polyureas, polyurethanes, urea/melamine-formaldehyde resin, polystyrene, polyacrylates
  - **Semi synthetic:** chitosan, cellulose and derivates, starch

- **Lipids:** cholesterol, phospholipids
- **Inorganic materials:** SiO₂

**Physicochemical characteristics depends on:**
- **Capsule type**
  - Type, size, membrane thickness, layer number
- **Shell**
  - Density, crystallinity, porosity, solubility, binders, pretreatments
- **External parameters**
  - Temperature, pH, humidity, solvents, mechanic action, intern/extern pressure
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<th><strong>Why encapsulation?</strong></th>
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| **Active substance protection** | • Against oxidation or deactivation due to reaction in the environment  
• Separation of incompatible materials |
| **Active substance properties modification** | • Masking organoleptic properties like color, taste, odor of substances  
• Safe handling of toxic actives |
| **Conversion of liquids to free flowing solids** | • Reducing costs allowing low cost handling equipment. |
| **Controlled and targeted release of encapsulated active compounds** | • Improving adhesion, penetration, or recognition of tissues and cells  
• Reducing active doses, and therefore potential toxicity of active. |
| **Release modification of encapsulated material** | • Providing sustained release → maintaining the right concentration  
• Providing triggered release by environmental changes in pH, temperature |
| **Marketing & product aesthetics** | • New opportunities to develop a novel generation of products.  
• More stable, efficient and biocompatible nanocapsules based-products |
Micro- and nanocapsules application in market
Micro- and nanocapsules application in market

- Self-Healing Polymers
- Intelligent Temperature Management for Buildings
- Nanochromics® Reflective & bistable low power consumption
- Capsules - Nutrition - Construction
- Hot laminatable "Printegration"
Micro- and nanocapsules application in market

Intelligent Temperature Management for Buildings

Textile

Construction

Capsules

Nutrition

Reflective & bistable Capsules

Nutrition

hot laminatable "Printegration"
Micro- and nanocapsules application in market

Intelligent Temperature Management for Buildings

Textile

Construction

Agriculture

Nutrition

Capsules

Germination stimulants
Phytotoxicity of herbicides / parasites
Micro- and nanocapsules application in market

Intelligent Temperature Management for Buildings

Textile

Construction

Nutrition

Agriculture

Cosmetic

Pharmacy

Medicine

Germination stimulants
Phytotoxicity of herbicides / parasites

Ciba
TINODERM™
Nanotopes™
Ultra Small Carriers

Pharmacy
1. Encapsulation

2. Micro- and nanoencapsulation at the ICN
Micro- and nanoencapsulation techniques

In-situ, interfacial & radical polymerization
- Melamine-formaldehyde, polyurethane, styrene, polyurea, polyamides, polyesters, silica, ethylcellulose

Simply and complex coacervation
- Gelatin, acacia and glutaraldehyde
- Casein, chitosan, PVA

Liposomes & Solid lipid nanoparticles
- Lipid cake hydration and homogeneization by extrusion, ultrasounds.

Emulsions
- Nanoemulsions, Double emulsions
- Polymeric surfactants

Spray-Drying
- Particle miniaturization (300nm -100µm)
- Encapsulate peptides, drugs, food ingredients
Micro- and nanoencapsulation facilities at ICN

Nanochemical lab
- Rotary evaporator
- Freezer -80°C
- Liophilizer
- Ultracentrifuge

Spray-Drying
- Nanospray spray drier (Büchi)
- Mini Spray Drier (Büchi)
- Particle miniaturization

Extrusion
- LIPEX™ extruder - for vesicle preparation
- 10mL scale Northen Lipids

Bench scale mixers
- Overhead stirrers
- Ultraturrax (IKA)

High pressure homogenization
- M-110L Microfluidizer Processor
- High shear fluids processing
- Microfluidics

Pilot plant reactor
- Dispermat CN 0.5 – 40 litres
- Dissolver

Characterization
- SEM, TEM, cryo-TEM
- Confocal microscopy
- DLS, Mastersizer
- Turbiscan
- SAXS-WAXS
- UV-Vis / IR-ATR spectroscopy
Supramolecular NanoChemistry & Materials

- Fungicides
- Fragrances
- Enzymes
- Cosmetics
- Biocides
- New Delivery Systems

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ICN Institute of Nanotechnology