MICROENCAPSULATION PATENTS – A SOURCE OF INNOVATION AND TREND ANALYSIS

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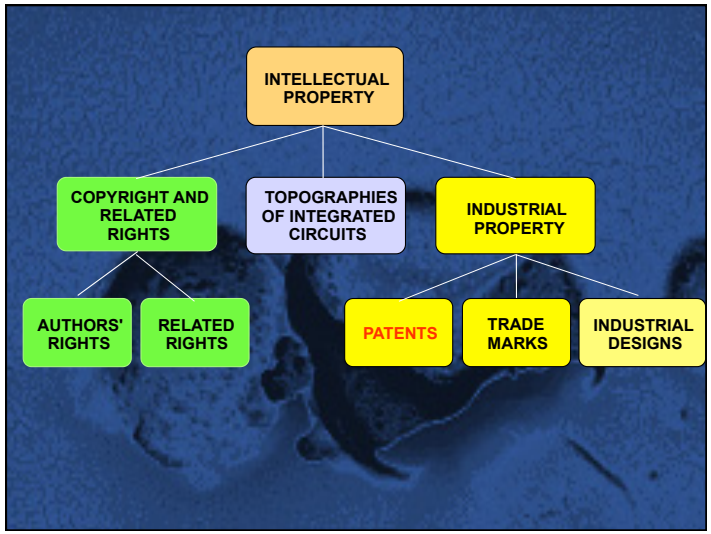
1. Introduction

Microencapsulation

- knowledge intensive research field
- basic research + industrial applications
- rapid growth of publications



Patents: legal protection of inventions

- exclusive right to make use of an invention (defined period, limited geographic area),
- the right to stop others from making, using or selling the claimed invention without authorisation

Patents: literature source

- newest information on innovative developments
- before scientific articles and conferences (no prior disclosure)
- 70% of information in patents never published elsewhere

2. Materials and methods

Databases

- Web of Science (IZUM) - payable
- Chemical Abstracts Plus (STN International) - payable
- Espacenet (http://ep.espacenet.com/) - free

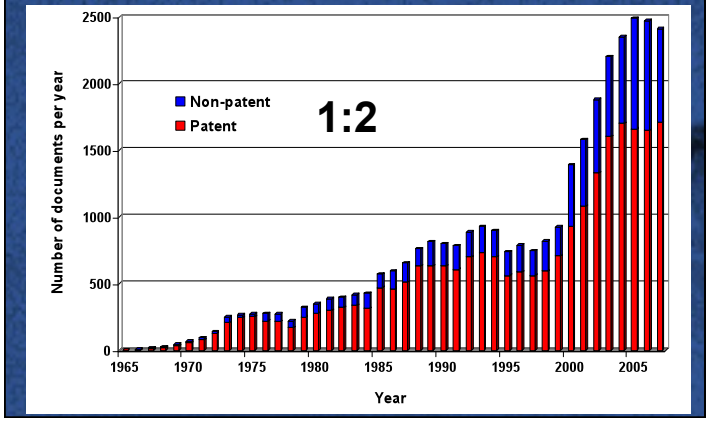
Information methods for patent analysis

(1) Value-added processing of a bibliographic part of patent documents for the definition of trends (Kardos et al., 2000)

(2) Structuring of data into systems for the analysis of contents - full text documents (Kornhauser, 1989)

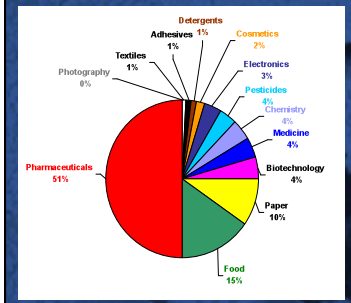
3. Results and discussion

Patents *vs.* scientific articles on microencapsulation (CAPlus database)



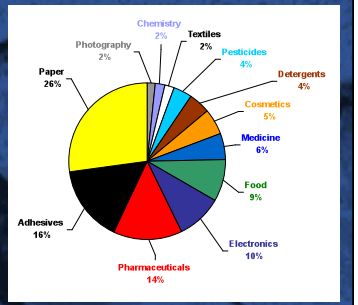
Microencapsulation fields – comparison of fundamental *vs.* industrial research

Scientific articles



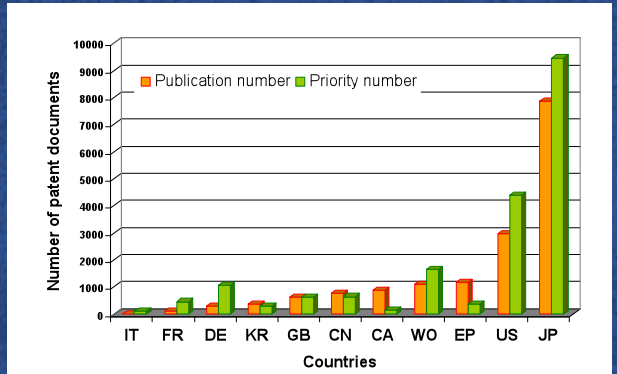
Database: Web of science

Patents



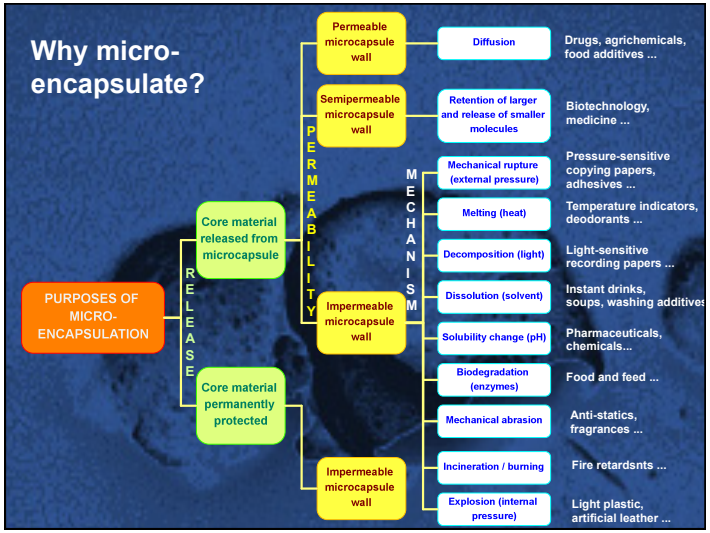
Database: Espacenet

LEADING COUNTRIES :
Patent documents on microencapsulation by country



Espacenet Advanced Search : Keyword(s) in title or abstract: *microcapsul*or microencap*) AND* Publication number / Priority number

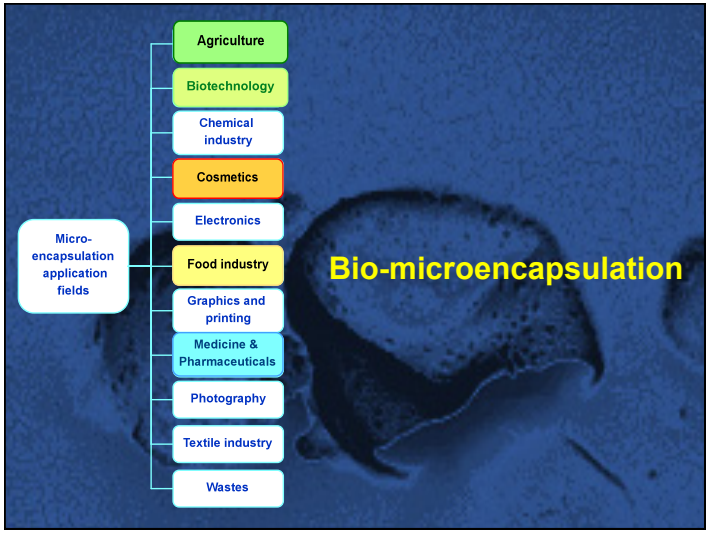
Why micro-encapsulate?

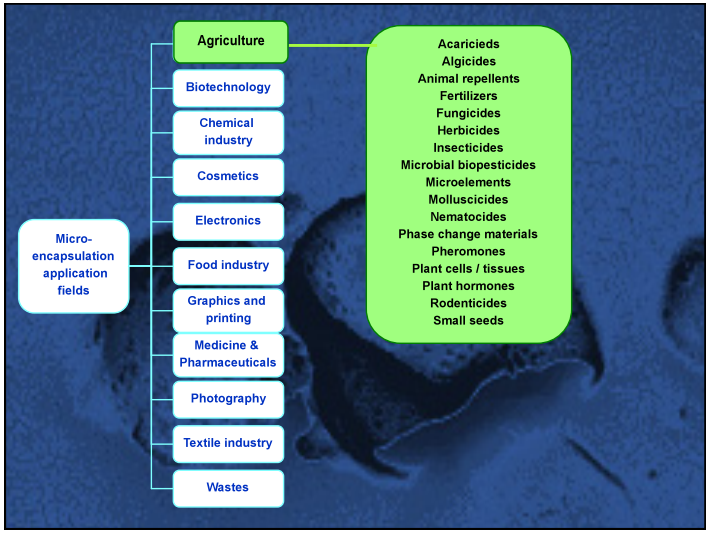


Selected examples of new industrial developments

1. Electronic ink displays
2. Materials science – self healing composite materials
3. Phase change materials (PCM)
4. Scientifically advanced cosmetics
5. Innovative bio-encapsulation delivery systems

Bio-microencapsulation applications


Micro-encapsulation application fields
Agriculture
Biotechnology
Chemical industry
Cosmetics
Electronics
Food industry
Graphics and printing
Medicine & Pharmaceuticals
Photography
Textile industry
Wastes
Bio-microencapsulation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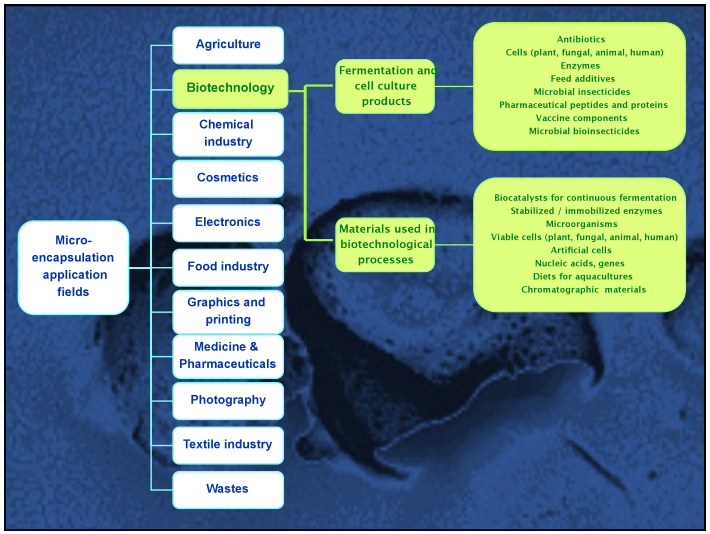
Electronics
Food industry
Graphics and printing
Medicine & Pharmaceuticals
Photography
Textile industry
Wastes
Acaricieds
Algicides
Animal repellents
Fertilizers
Fungicides
Herbicides
Insecticides
Microbial biopesticides
Microelements
Molluscicides
Nematocides
Phase change materials
Pheromones
Plant cells / tissues
Plant hormones
Rodenticides
Small seeds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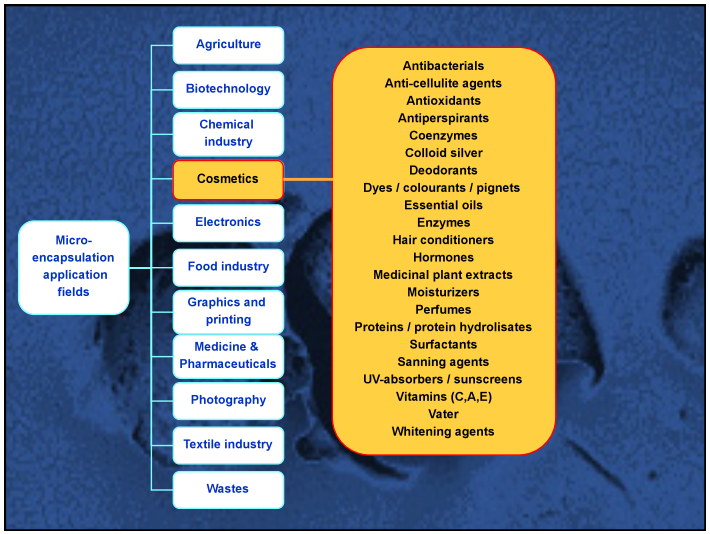
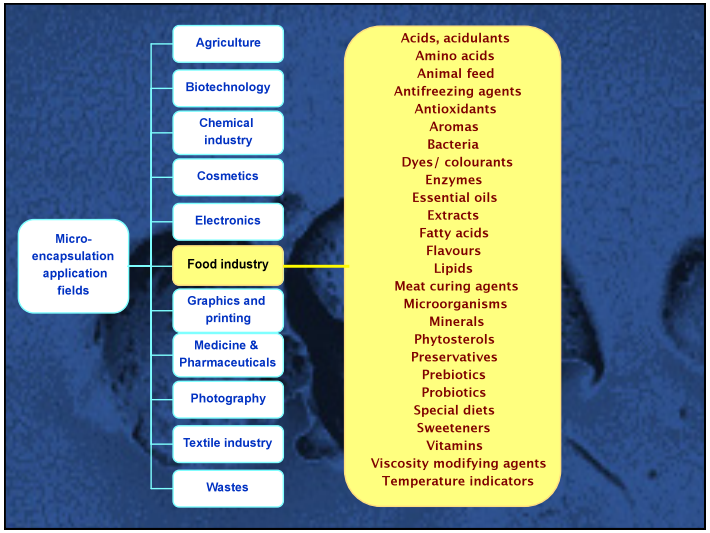
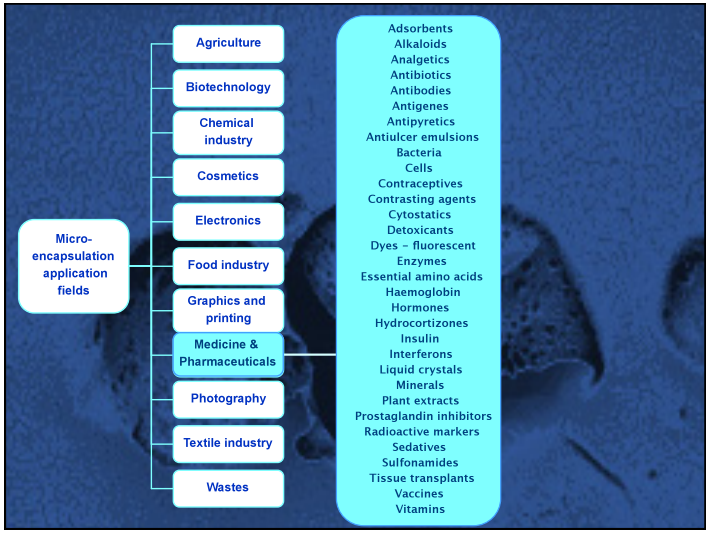
Agriculture
Biotechnology
Chemical industry
Cosmetics
Electronics
Food industry
Graphics and printing
Medicine & Pharmaceuticals
Photography
Textile industry
Wastes
Fermentation and cell culture products
Antibiotics
Cells (plant, fungal, animal, human)
Enzymes
Feed additives
Microbial insecticides
Pharmaceutical peptides and proteins
Vaccine components
Microbial bioinsecticides
Materials used in biotechnological processes
Biocatalysts for continuous fermentation
Stabilized / immobilized enzymes
Microorganisms
Viable cells (plant, fungal, animal, human)
Artificial cells
Nucleic acids, genes
Diets for aquacultures
Chromatographic materials


Micro-encapsulation application fields
Agriculture
Biotechnology
Chemical industry
Cosmetics
Electronics
Food industry
Graphics and printing
Medicine & Pharmaceuticals
Photography
Textile industry
Wastes
Antibacterials
Anti-cellulite agents
Antioxidants
Antiperspirants
Coenzymes
Colloid silver
Deodorants
Dyes / colourants / pignets
Essential oils
Enzymes
Hair conditioners
Hormones
Medicinal plant extracts
Moisturizers
Perfumes
Proteins / protein hydrolisates
Surfactants
Sanning agents
UV-absorbers / sunscreens
Vitamins (C,A,E)
Vater
Whitening agents



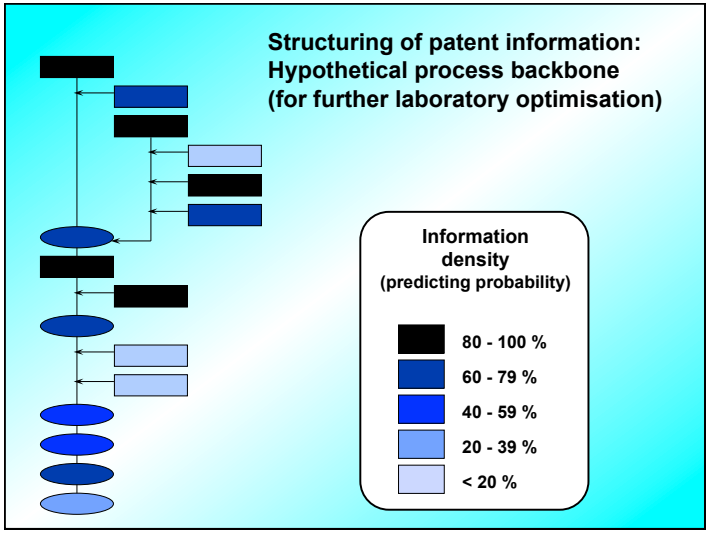


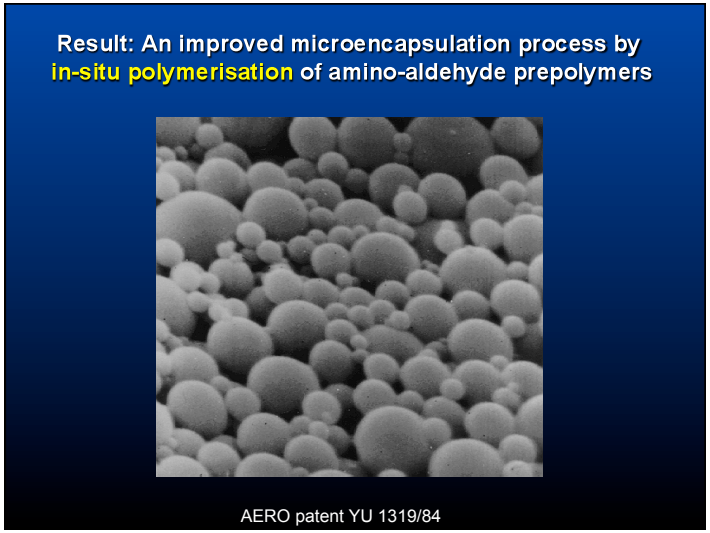
University-Industry Cooperation between University of Ljubljana and Aero d.d.

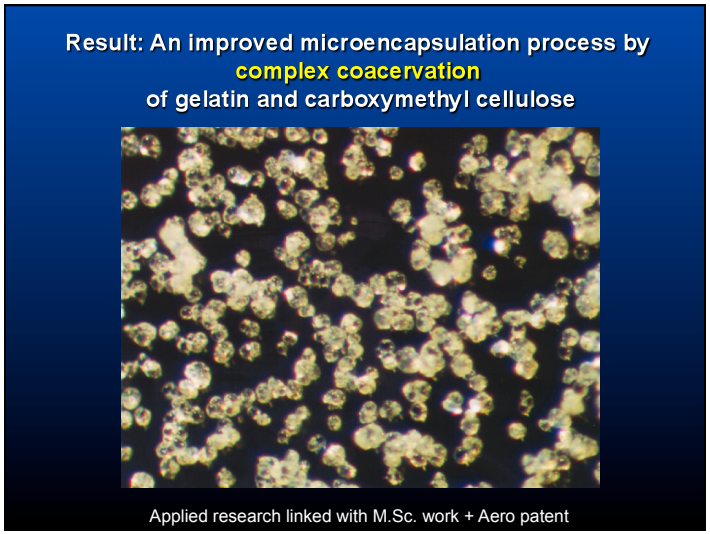
- 25 years of cooperation in information-supported R&D
- microencapsulation technologies
- applications in graphics, printing, agrochemicals, food and textiles

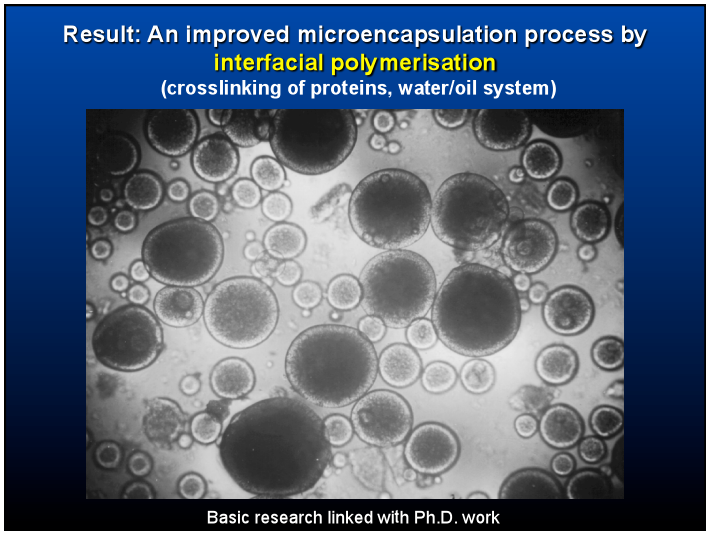
Information system:
a core of university-industry cooperation

1. Structuring of data for designing improved microencapsulation processes
2. Searching for free application niches for R&D of new products


Structuring of patent information:
Hypothetical process backbone
(for further laboratory optimisation)
Information
density
(predicting probability)
80 - 100 %
60 - 79 %
40 - 59 %
20 - 39 %
< 20 %


Result: An improved microencapsulation process by
in-situ polymerisation of amino-aldehyde prepolymers
AERO patent YU 1319/84

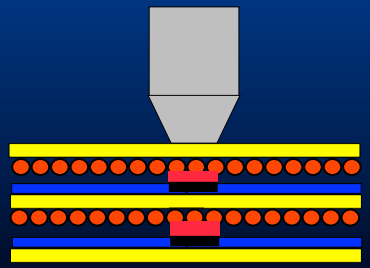

Result: An improved microencapsulation process by
complex coacervation
of gelatin and carboxymethyl cellulose
Applied research linked with M.Sc. work + Aero patent


Result: An improved microencapsulation process by
interfacial polymerisation
(crosslinking of proteins, water/oil system)
Basic research linked with Ph.D. work

2. Searching for free application niches for R&D of new products

Example 1
Graphics and printing :
Self-contained printing ink
Fragranced printing ink

Pressure-sensitive copying paper

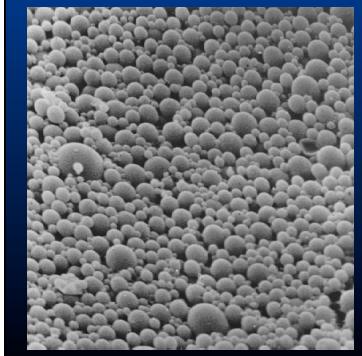


PAPER

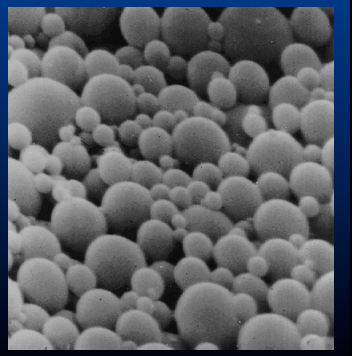
MICROENCAPSULATED LEUCO DYE

DEVELOPER

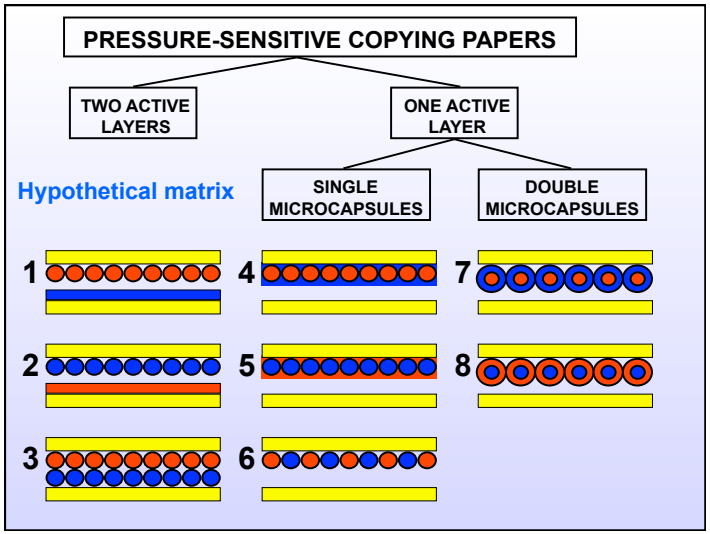
Scanning electron micrograph of microcapsules on paper

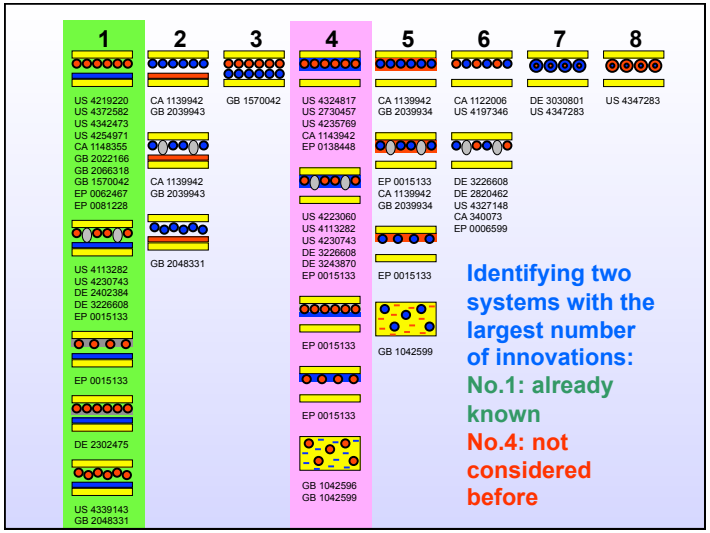


(C+Au/Pd, 1900x)

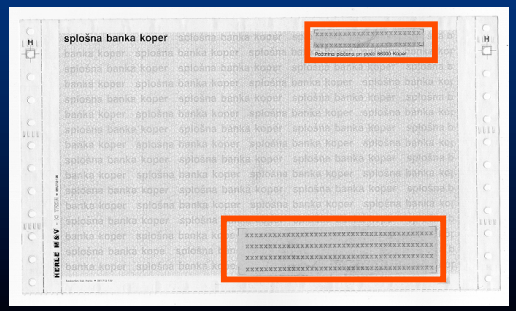


(C+Au/Pd, 6320x)





Pressure-sensitive printing ink for bank mailers (Aero patent SI 9300539)



Pressure-sensitive printing ink for scented repositionable paper notes

(microencapsulated fragrances: *Citrus*, *Lavandula*, rose, strawberry)

Example 2:

Food industry:

Aromatised tea

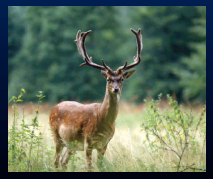
Microencapsulated aromas for tea
(Aero patent SI 9110034)

Example 3:

Agriculture: microencapsulated animal repellents

Prolonged release formulations:

- aqueous microcapsule suspension concentrates (Aromit MK®)
- thickened pastes
- coated or impregnated carriers: non-woven textiles, paper

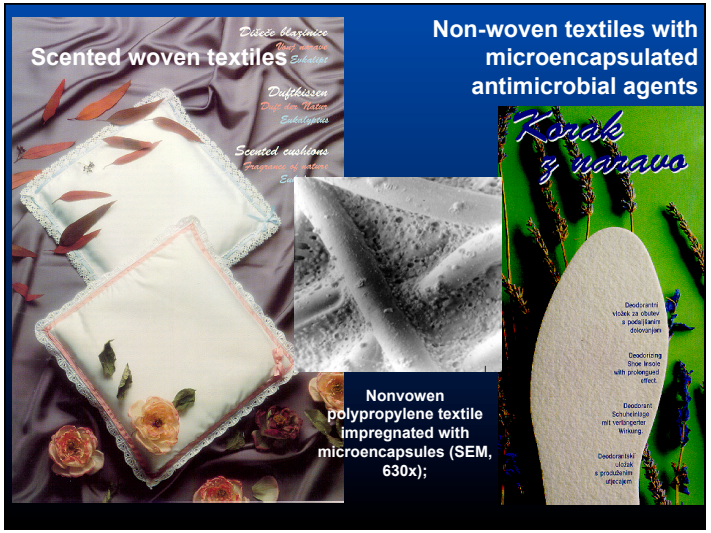


roe deer *Capreolus capreolus* L.

rabbits *Lepus europaeus* Pallas

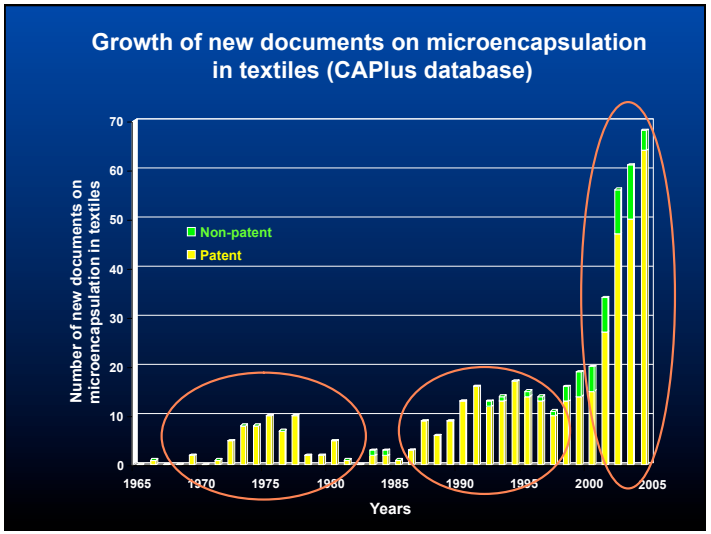
Example 4:

Antimicrobial fragranced textiles



Example 5:

Microencapsulated Phase Change Materials (PCM)

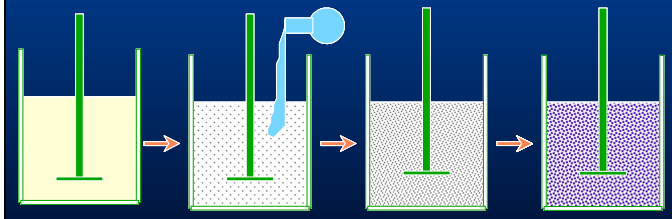


Phase change materials (PCMs)

- Sub-group of heat storage materials (heat exchange process at the melting point)
- Solid to liquid: energy is stored
- Liquid to solid: energy is released
- Microencapsulation
- Applications in textiles: sports wear, diving suits, fire wear, special working clothes, gloves, shoes

Modified *in situ* polymerisation process

patents SI 8411319 (1995), and EP 0782475 (1997), Aero d.d.



Water + aminoaldehyde resin + anionic polyelectrolyte modifying agent

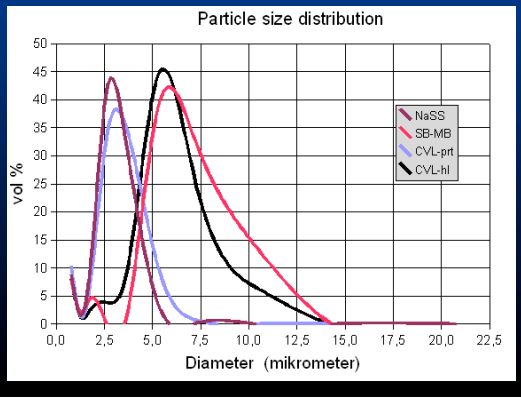
Emulsification of a lipophylic core material (active substance)

Polycondensation (change of temperature and pH)

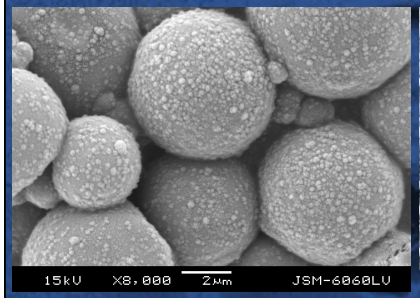
Microcapsule hardening, removal of residual monomers

Size distribution of microcapsules

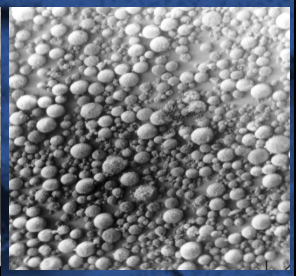
(small microcapsules 2,5 mm, large microcapsules 6,0 mm)



PCM microcapsules resistant to mechanical and thermal stress produced by the modified *in situ* polymerisation process



Individual microcapsules of PCMs (SEM, 8000 x).



Spray dried granules of microencapsulated PCMs (SEM, 190x).

4. Conclusions

Conclusions

- **Microencapsulation - multidisciplinary field, several technologies, numerous application fields**
- **Rapid growth of information, large proportion of patents,**
- **Ability to analyse and structure large amounts of information; transformation into knowledge**
- **Pharmaceutical, biotechnological, chemical companies - a crucial role of industrial intellectual property (competitiveness, identification of market niches)**

Acknowledgements

Aero R&D: E. Knez, M. Kukovič, B. Šumiga

The projects were co-financed by the
Slovenian Ministry of Science and Technology (MZT),
Slovenian Research Agency (ARRS), and
Aero Chemical, Graphic and Paper Manufacturers, Celje