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Nanocellulosic Materials and Nanocomposites

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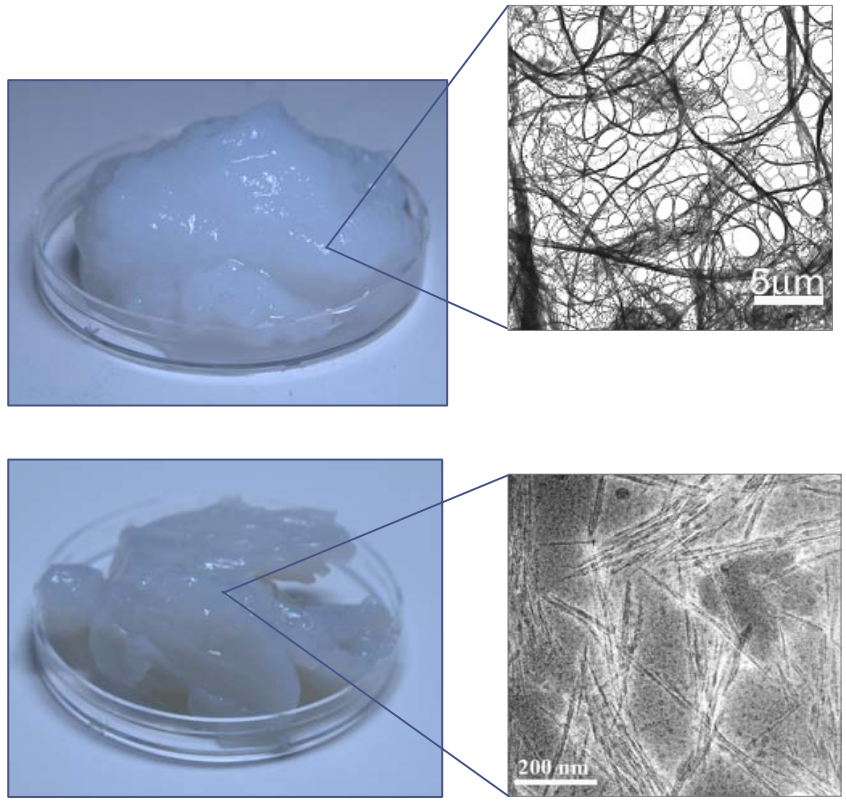
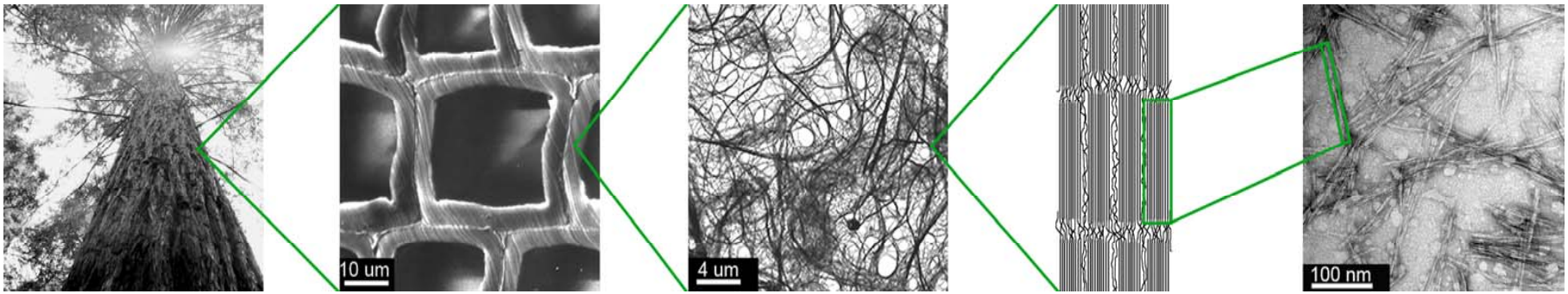
Nanocelluloses and nanocomposites

- Nanocellulosic materials
  - Nanofibers/fibrils
  - Nanocrystals/whiskers
  - <100 nm in one dimension
- Nanocomposites
  - Polymer where the nano-sized cellulose is used to improve the properties

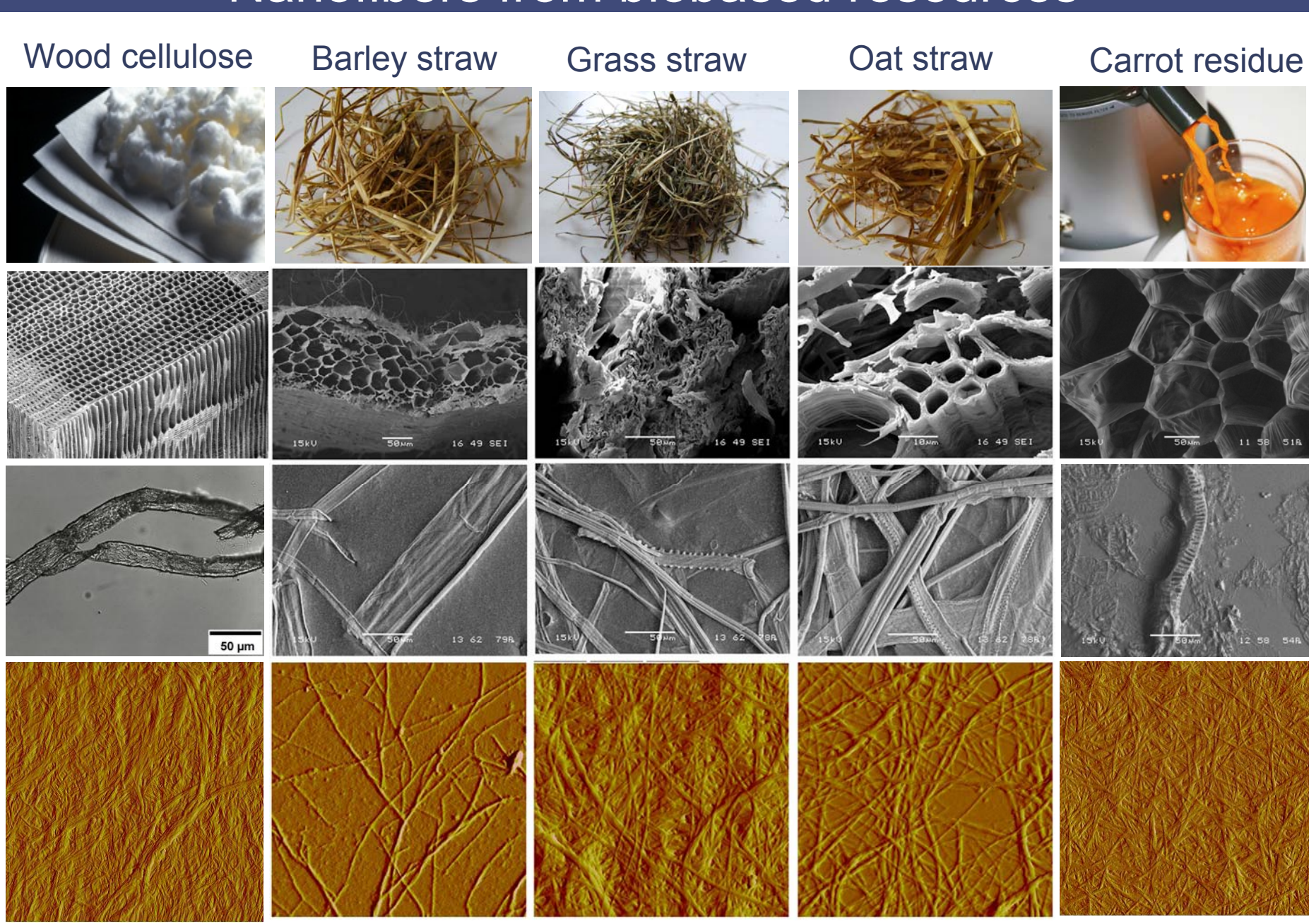


Hierarchical structure of wood



- Soft wood fiber, diam 20-30 μm, length 2-5 mm
- Nanofibers, diam ~ 10-50 nm, length ~ μm
- Crystallites, width < 5 nm, length < 300 nm

Nanofibers from biobased resources

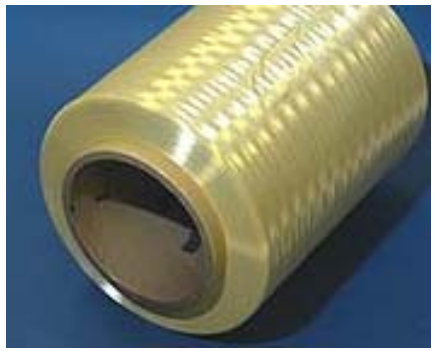


Cellulose based nanocomposites

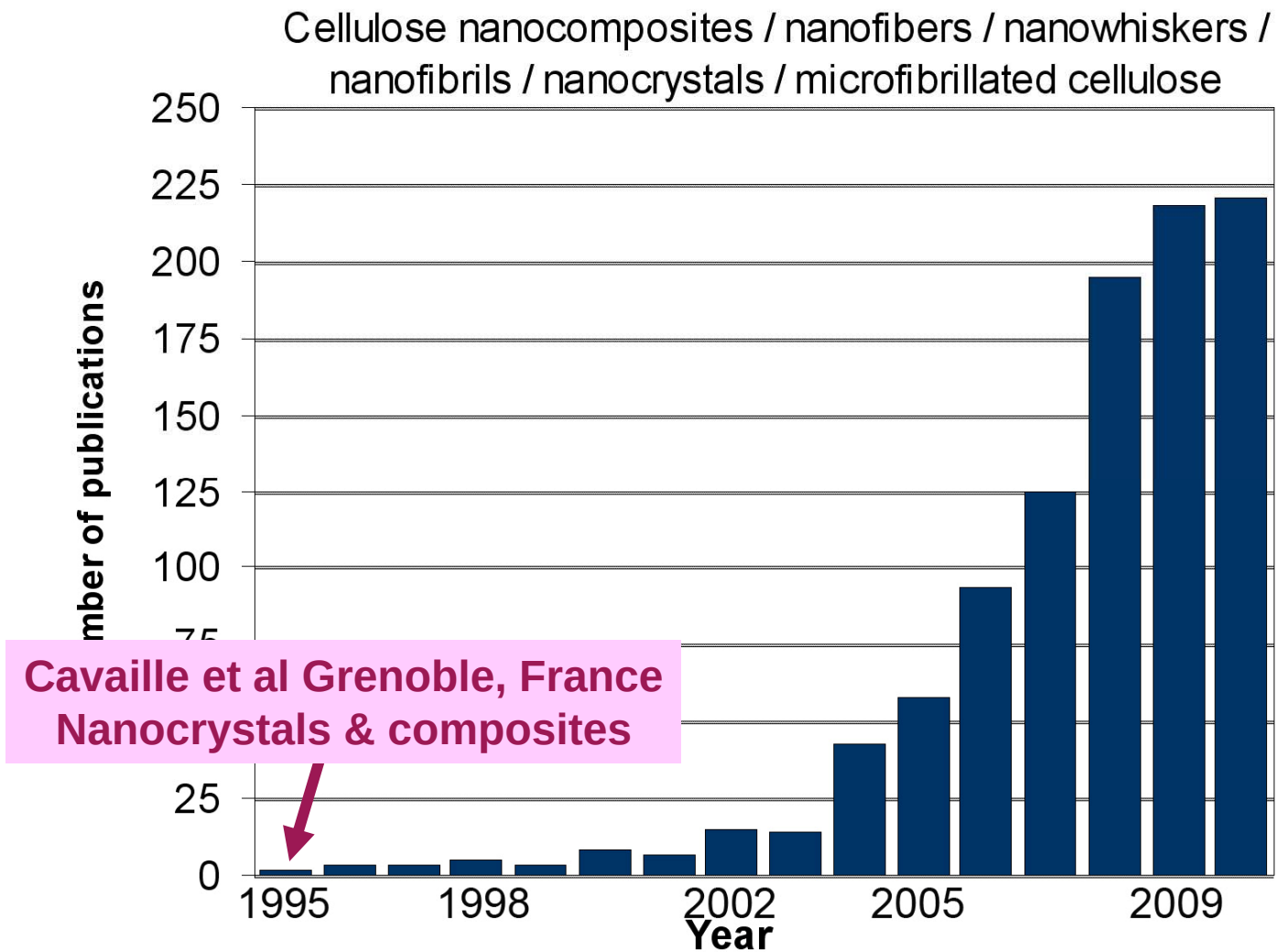
Cellulose nanofibers or crystals as reinforcements or additives in polymers

Interesting properties

- *High mechanical properties*
- *High thermal stability*
- *Large surface area*
- *Bio-compatible*
- *Light weight*
- *Optical transparency*
- *High water binding capability*



Research on nanocellulose materials and composites: 1995-2010



ISI Web of Knowledge, Sept 2010

Activities today

- Research acivities are focussed on
  - Raw materials sources & separation
  - Composite materials development
  - Properties
  - Large scale / pilot scale production methods
  - Chemical modifications
  - Modelling
  - Organized structures

H Yano Kyoto, Japan

Cellu Comp, Carrot Stix™
www.cellucomp.com

Sport goods: With over 50,000 Carrot Stix rods sold in the past 18 months, the Carrot Stix is the best-selling product in its price category (Nanopatents and Innovations March 2010)

Commercial scale-up

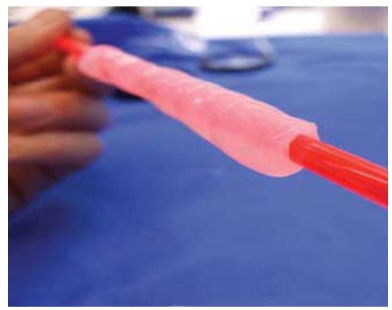
- Japan, Daicel, MFC
- Scotland, CelluComp, Nanofibers and composites
- Sweden, Innventia, MFC/nanofibers
- Canada, FPInnovation, Arboranano, Nanocrystals, Green Core Composites, MFC and composites
- Finland, UPM Kymmene &VTT, MFC
- Norway, Borregaard, MFC
- Germany, Rettenmaier, MFC

Cellulose nanocomposite applications

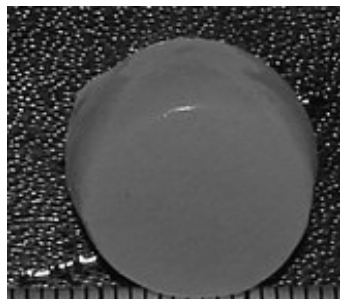
For medical uses

- Ligament and tendon replacement, LTU, Sweden
- Replacement of human blood vessels and caritilage, Chalmers, Sweden
- Hydrogels for replacement of fibrocartilage in the spine, EMPA, Switzerland
- Other products are nanocelluloses for wound healing

AP Mathew, LTU, Sweden



P Gatenholm, Chalmers, Sweden



Ch Eyholzer et al, EMPA, Switzerland

Other applications

- Transparent and foldable displays
- Automotive applications
- Sport goods
- Light weight batteries
- Cosmetics
- Packaging applications
- Technical textiles

H Yano Kyoto, Japan

CelluComp

I would like to thank

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Characterization Techniques

Nanocelluloses and Nanocomposites

A Mathew, T Zimmermann, H Yano, M Henriksson,

A Nakagaito, A Isogai, T Lindström, R Moon,

J Simonsen, A Bismarck