

# Nanocomposites Coatings for Wood Industries

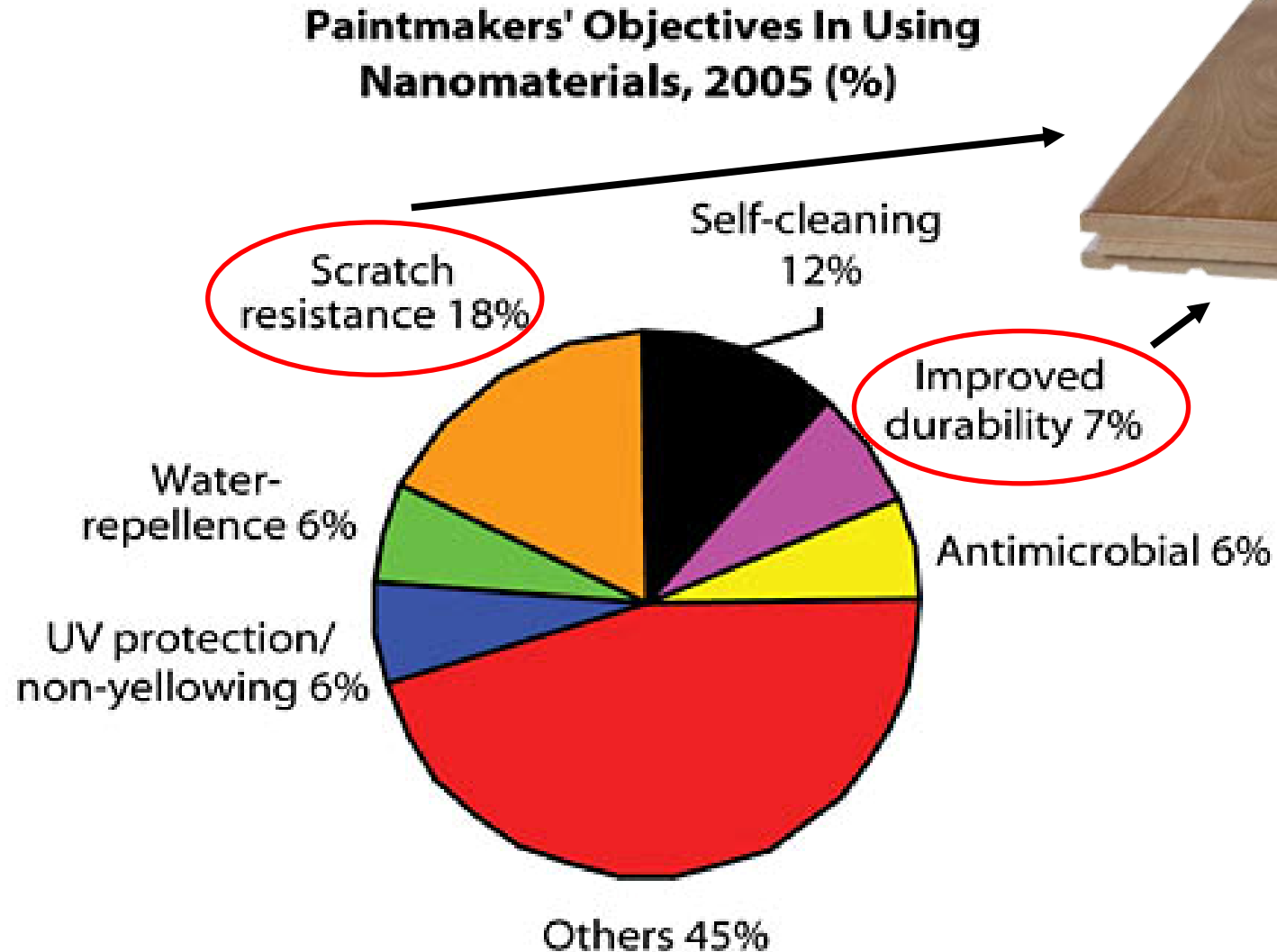
Véronic Landry and Pierre  
Blanchet

**FPI**nnovations

# Outline

- Nanotechnology in the coating industry
- Importance of UV-cured polymers
- Review on metal oxide and clay based nanocomposites coatings
- Next step : NCC-based nanocomposites coatings
  - Coatings Systems Used
  - Preliminary Results
- Conclusions
- Future Work

# Nanotechnology in the Coating Industry



# Our objectives

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- Improve the properties of UV high solids curable coatings with:
  1. Metal oxides
  2. Clay
  3. NCC
- Improve the properties of waterborne coatings (first step)

# UV Cured Polymers

## - Applications -

**Coatings:** Compact Discs, Hardwood Flooring, Upscale Shopping Bags, Optical Fibers, Furniture Laminates, Vacuum Metallized Plastic, Credit Cards, Beverage Cans, Photographic Film, Magazine Covers, Wall Paneling, Vinyl Floor Tile, Leather Finishes, Magnetic Media (tape & floppy disks), Galvanized Metal Tubing.



**Inks for:** Lithographic, letterpress, flexographic, gravure and screen printing

**Adhesives:** Automotive headlamps, Pressure sensitive labels and decals, Potting and encapsulation of electronic components, Plastic components assembly for the medical industry.



**Printing Plates:** Letterpress, flexographic and gravure.



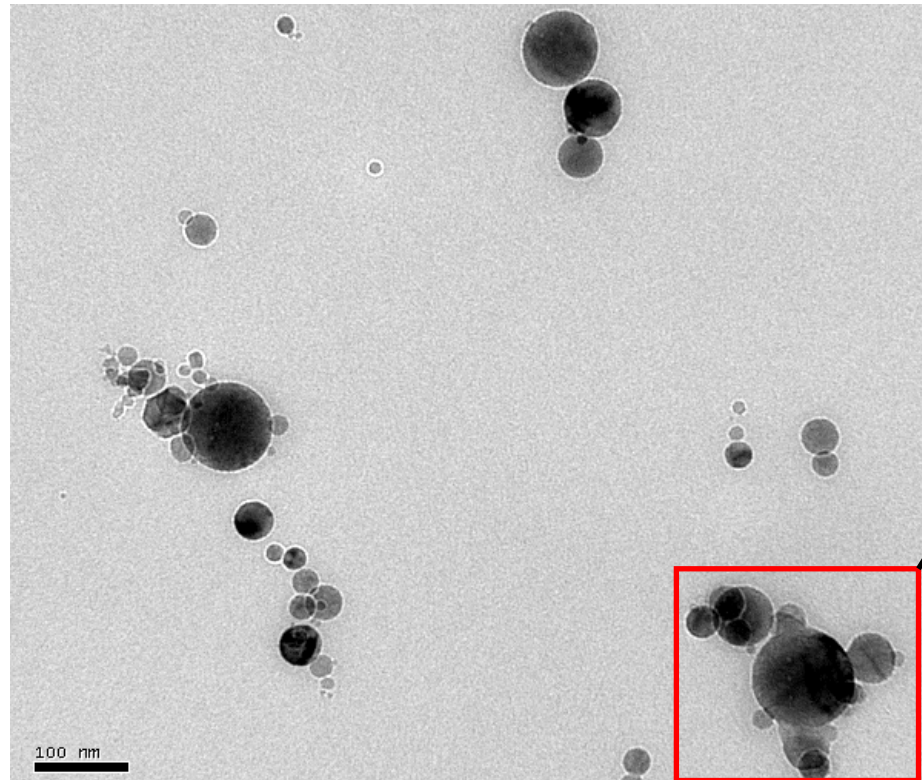
**Miscellaneous:** Dental fillings, Rapid prototyping resins



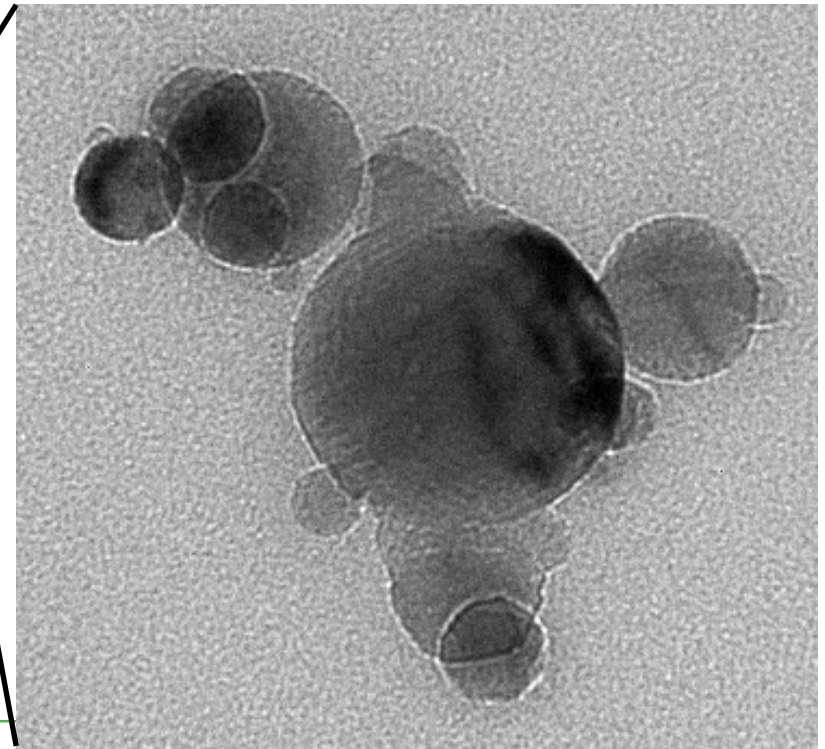


## - Review -

# Metal Oxide Nanocomposites Coatings

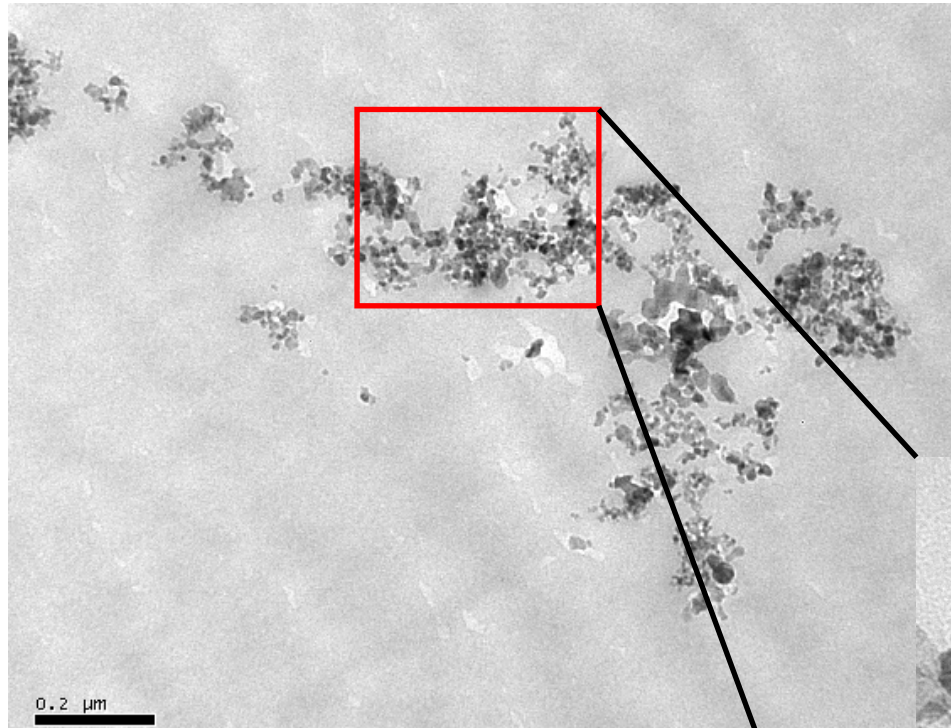


**Nanometric alumina  
(pre-dispersed)**

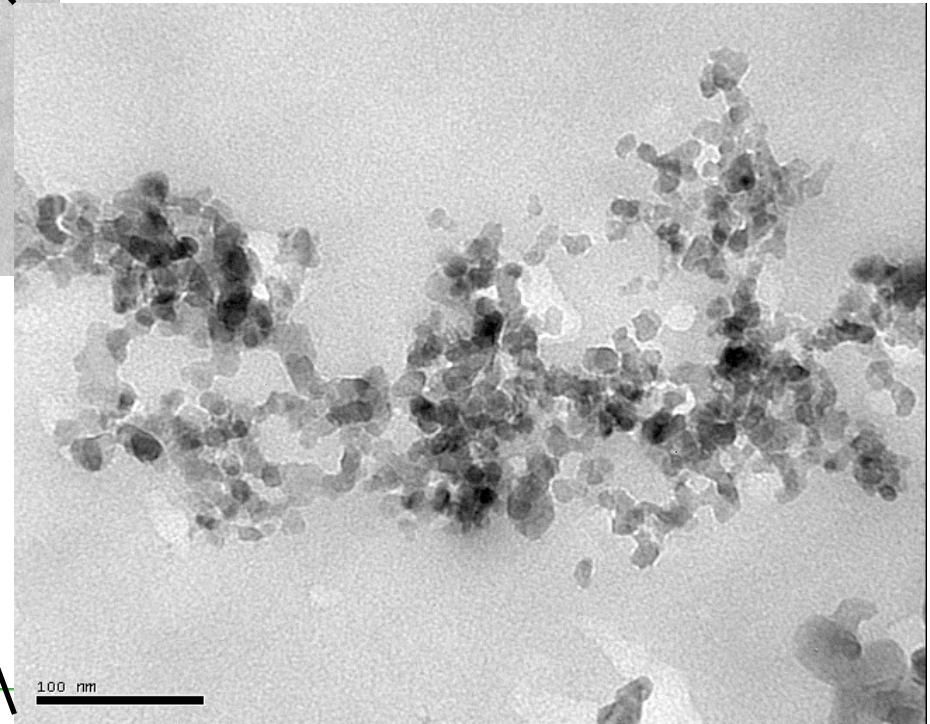


## - Review -

# Metal Oxide Nanocomposites Coatings



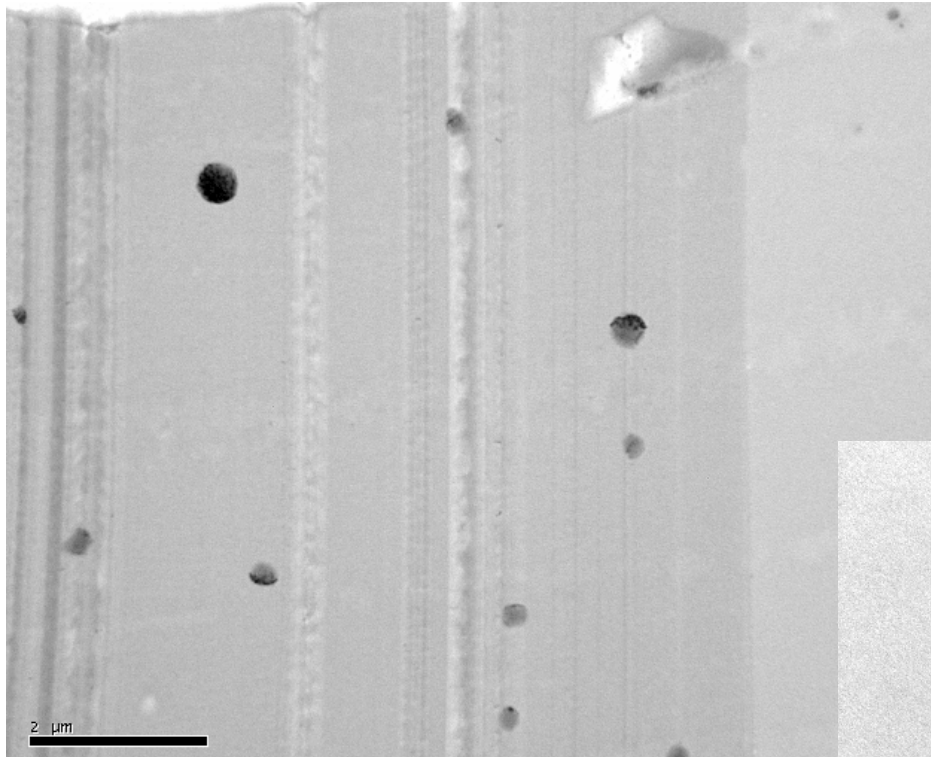
**Nanometric Alumina  
(powder)**



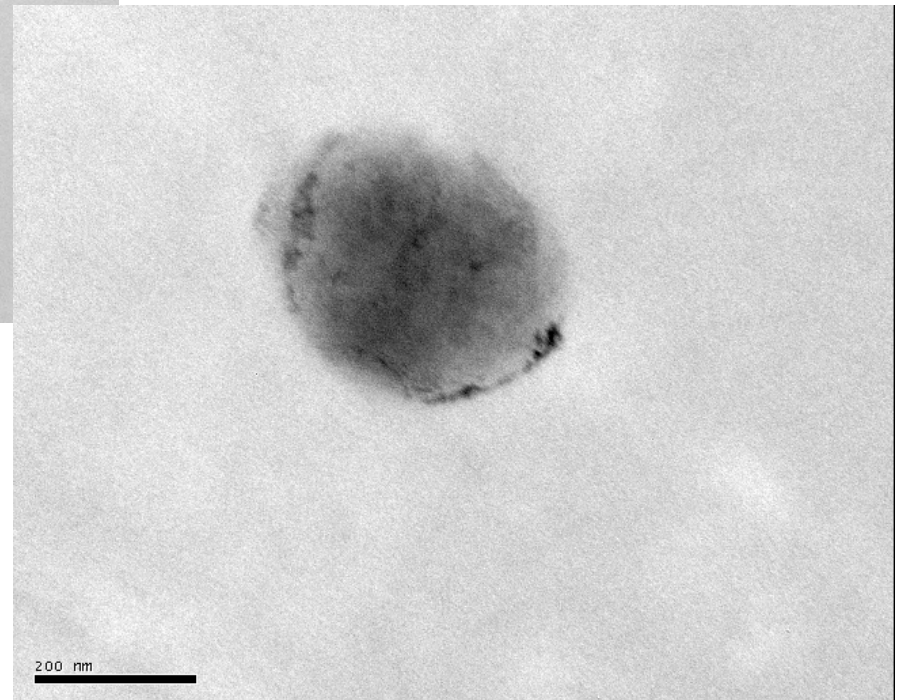


## - Review -

# Metal Oxide Nanocomposites Coatings



## Micrometric Alumina





## - Review -

# Metal Oxide Nanocomposites Coatings

## UV Curing Analysis

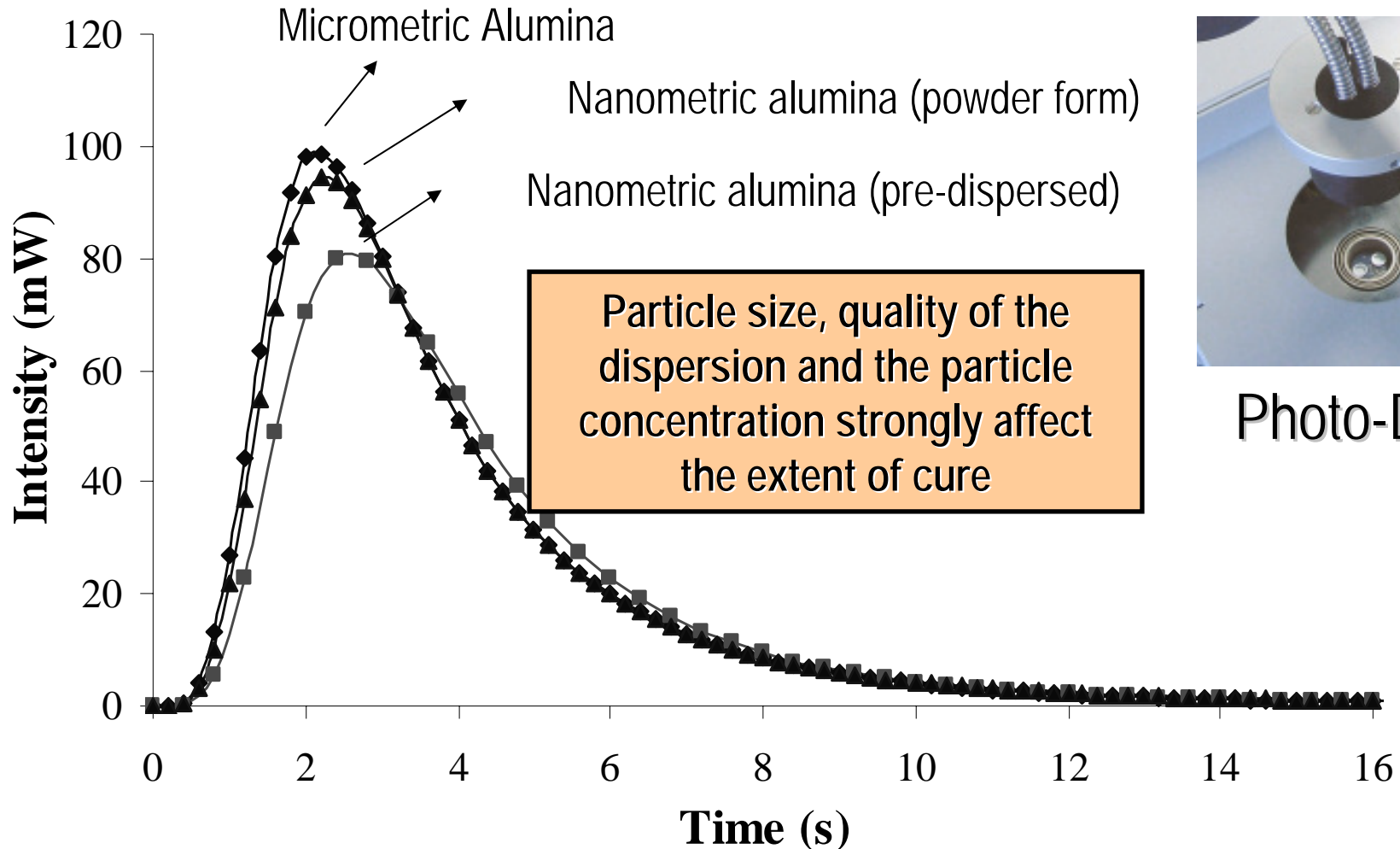
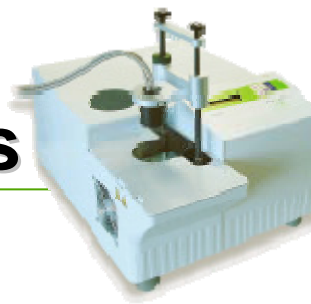
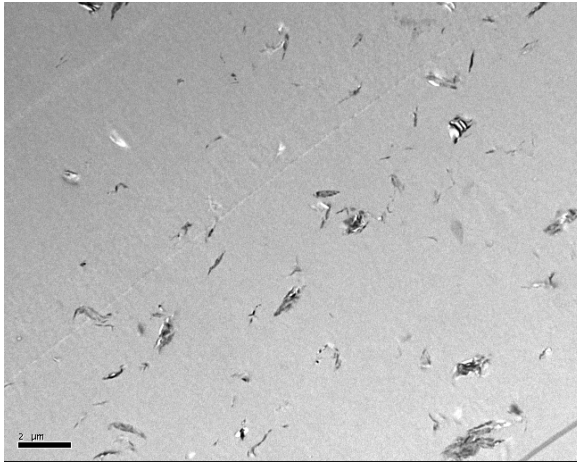


Photo-DSC

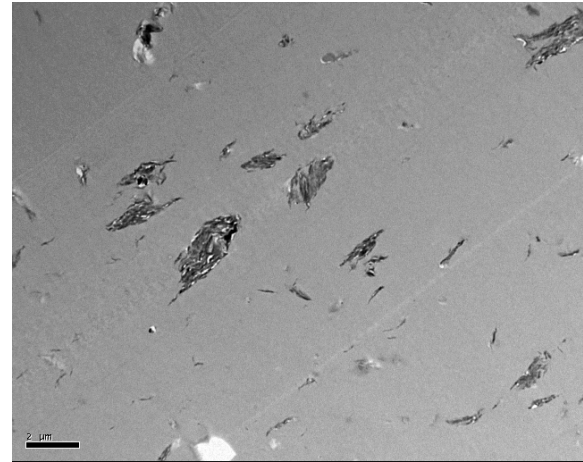
## - Review -

# Clay-based Nanocomposites Coatings

Formulations with 1 %wt of clay

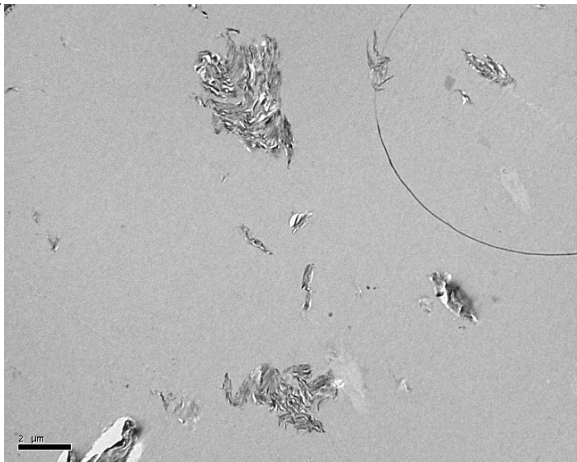


Three roll mill

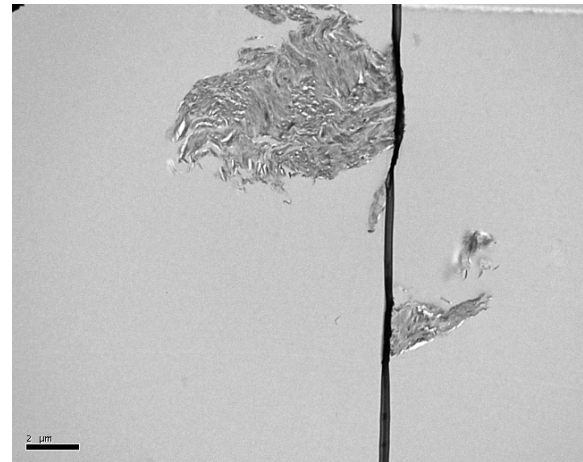


Bead mill

2 μm



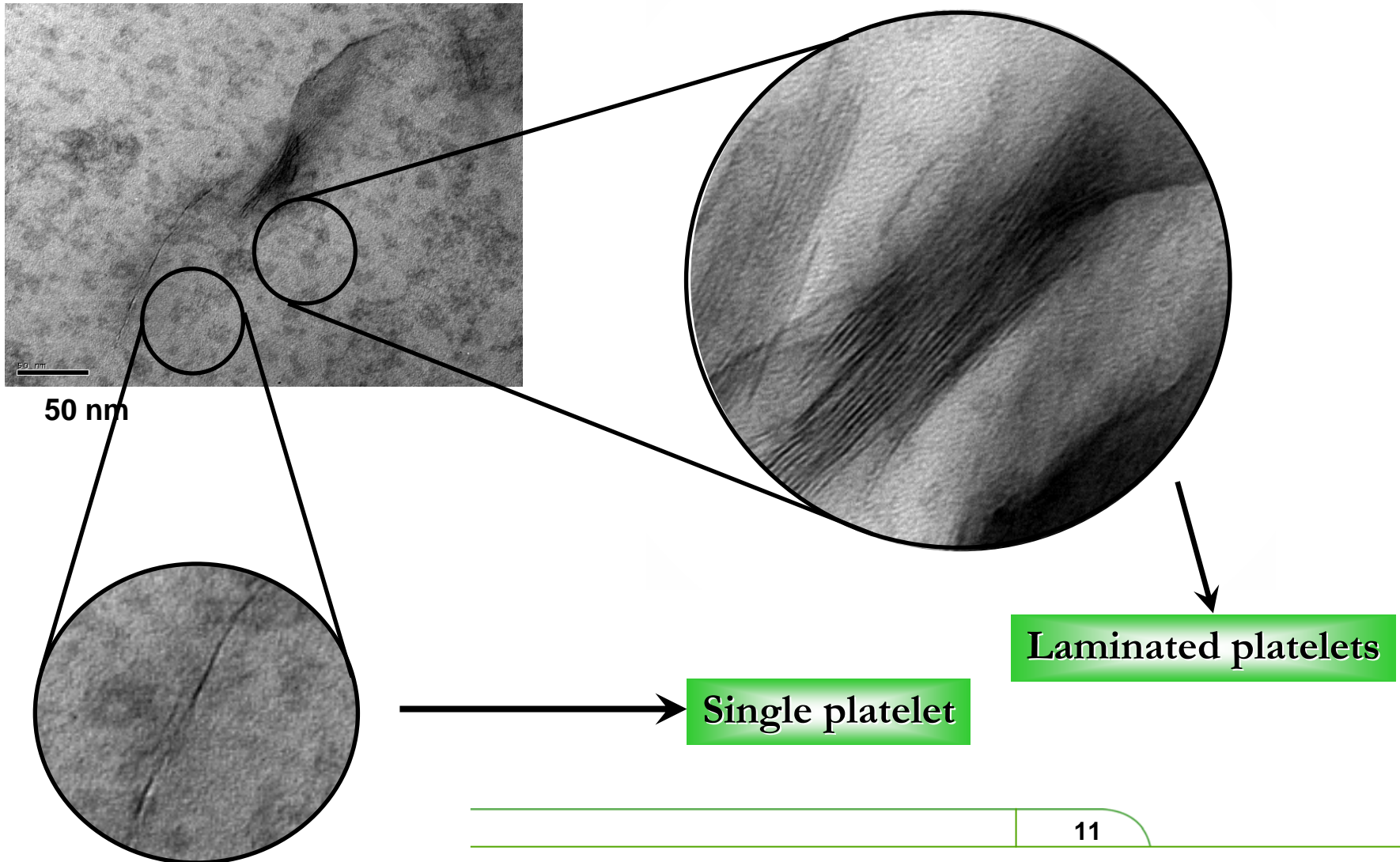
Ball mill



High speed mixer<sub>10</sub>

# Clay-based Nanocomposites Coatings

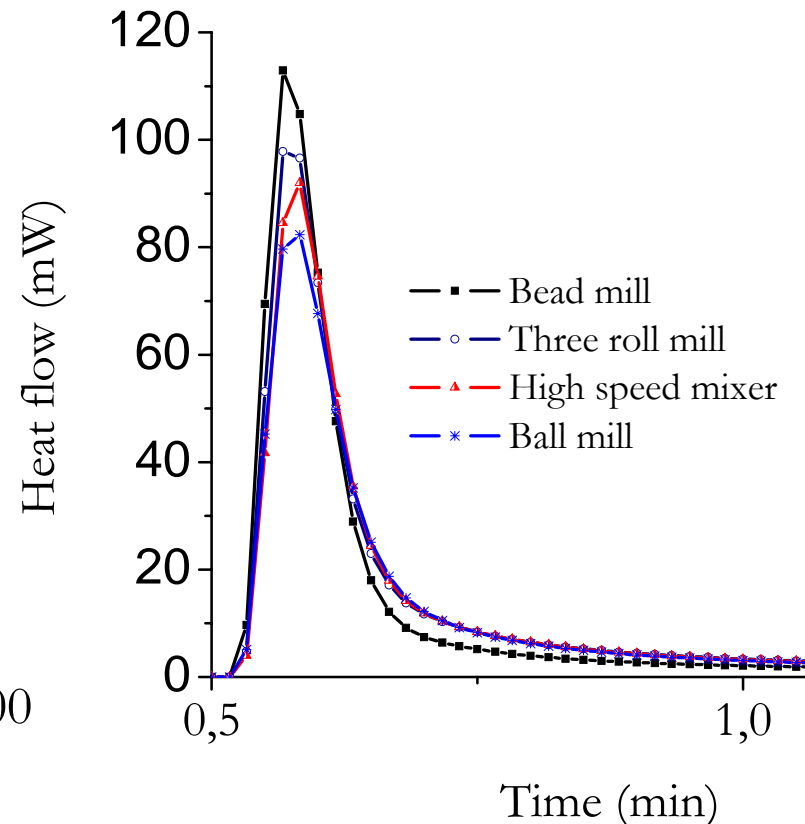
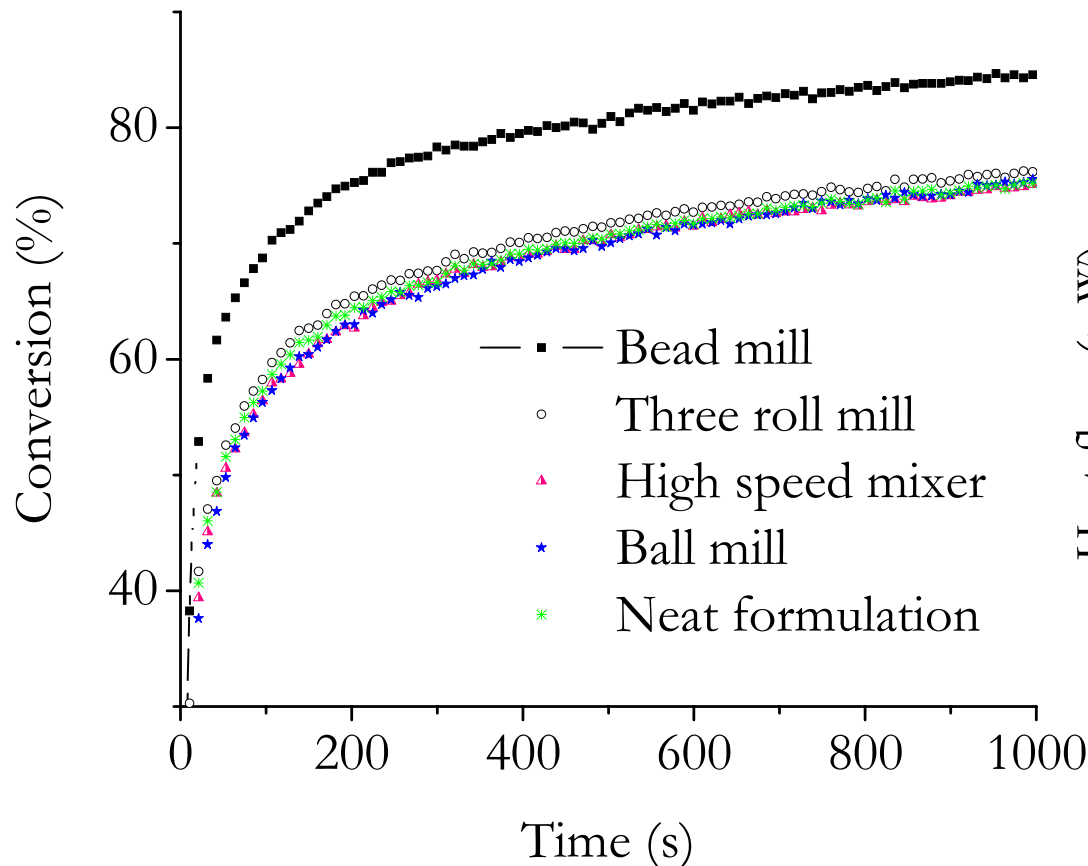
Formulation prepared by bead milling with 1%wt of clay



## Clay-based Nanocomposites Coatings

### Real-Time Infrared Spectroscopy – Treatment Comparison

Conversion profiles for the formulations prepared with 1%wt of clay for the different treatments





# What is next ? NCC

- **NCC is hydrophilic**
  - Ideal for waterborne coatings (acrylic lacquer, waterborne PU, etc.)
  - Difficult to incorporate in UV hydrophobic high solids coatings or solventborne coatings (NCC modification would be necessary)
- **Low toxicity** (compare to many inorganic fillers)
- NCC has relatively **low refractive index** (good for UV high solids coatings curing)
- **Good mechanical strength**

# First attempt : Acrylic Lacquer



- Available in building hardware, very easy to find
- Used for furniture, kitchen cabinets, molder, etc.
- Chemical and mechanical performance of acrylic lacquers is low compare to UV varnishes
- 30 % of solids by weight (70 % water)
- Acrylic emulsion
- NCC was added at 1 to 5 %wt (dry film)

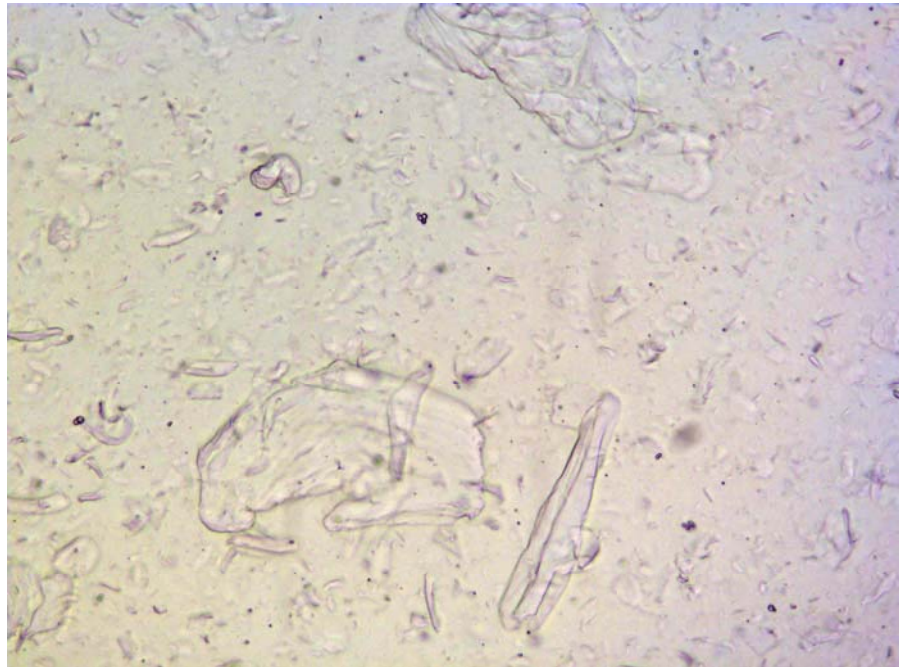


waterborne acrylic  
lacquers

Chemical and Mechanical Performance

# First attempt : Acrylic Lacquer

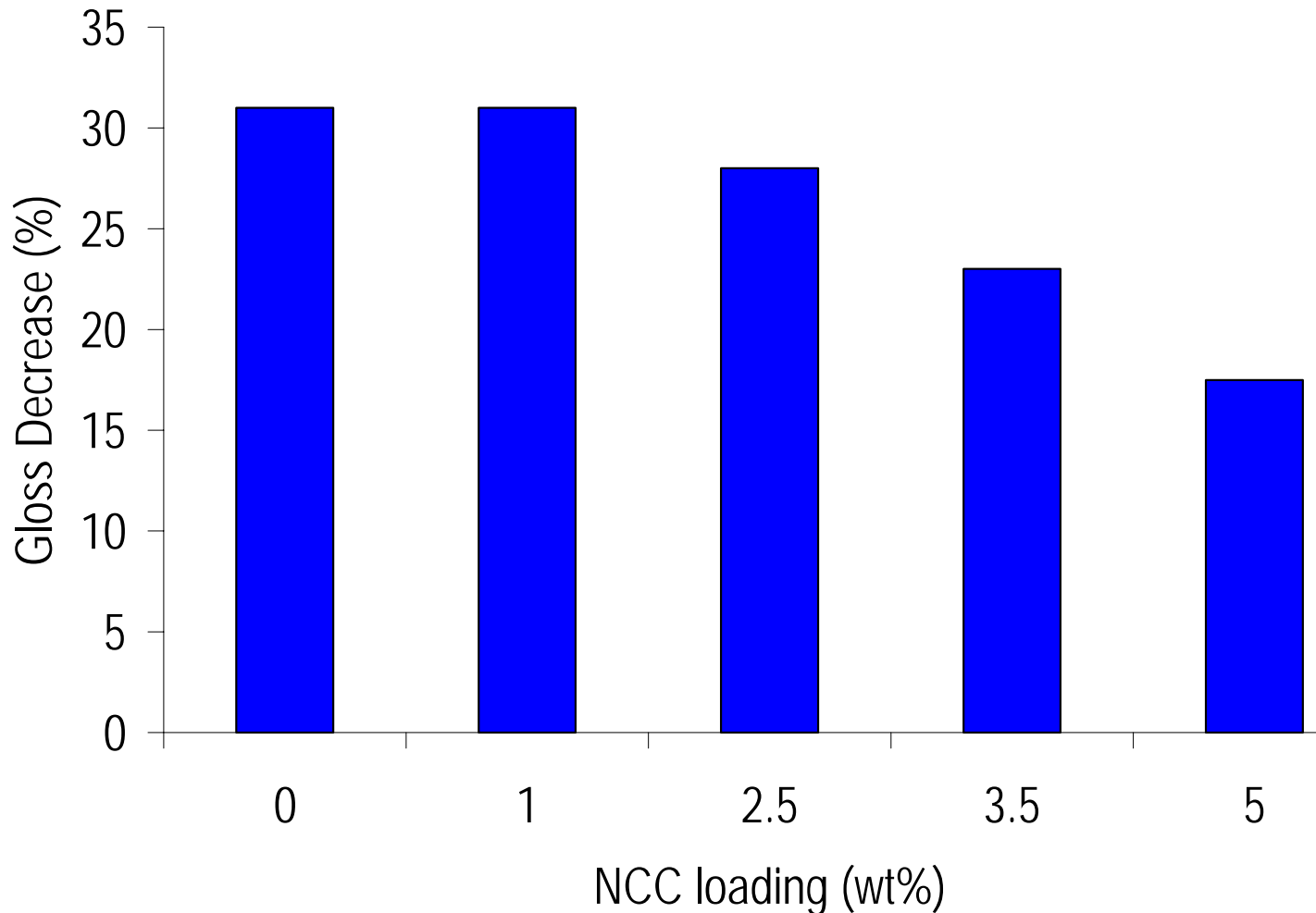
- NCC was dispersed in the waterborne lacquer in two different ways :
  1. Directly in the emulsion, then mixed.
  2. NCC was dispersed in water, then added in the acrylic resin.



# Mechanical Characterization

## Scratch resistance

Lower gloss decrease = better scratch resistance



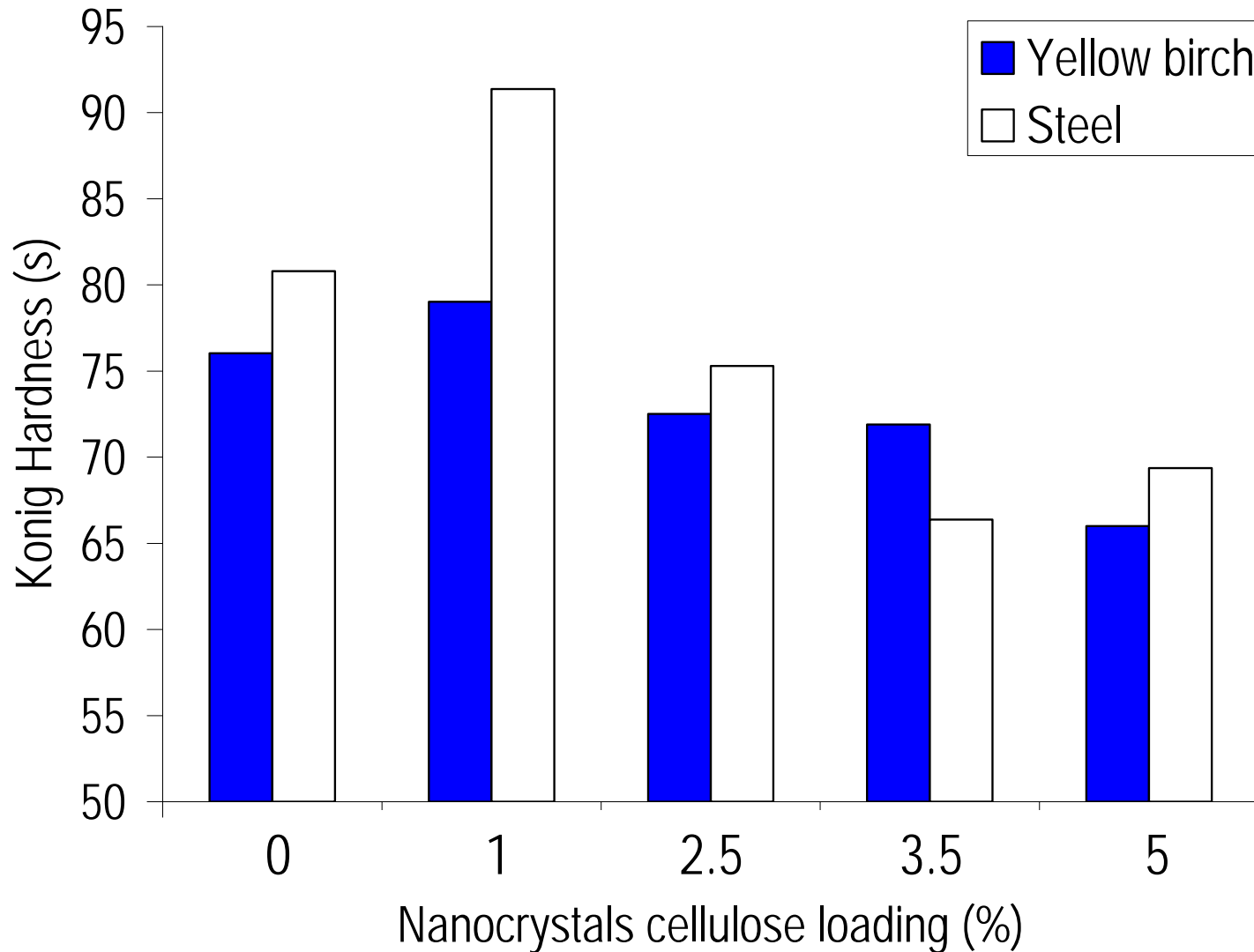
100 back and forth  
Scotch brite





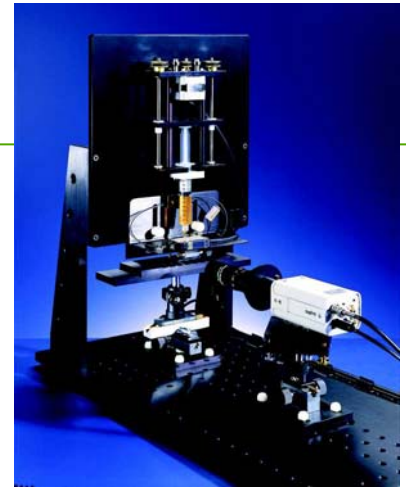
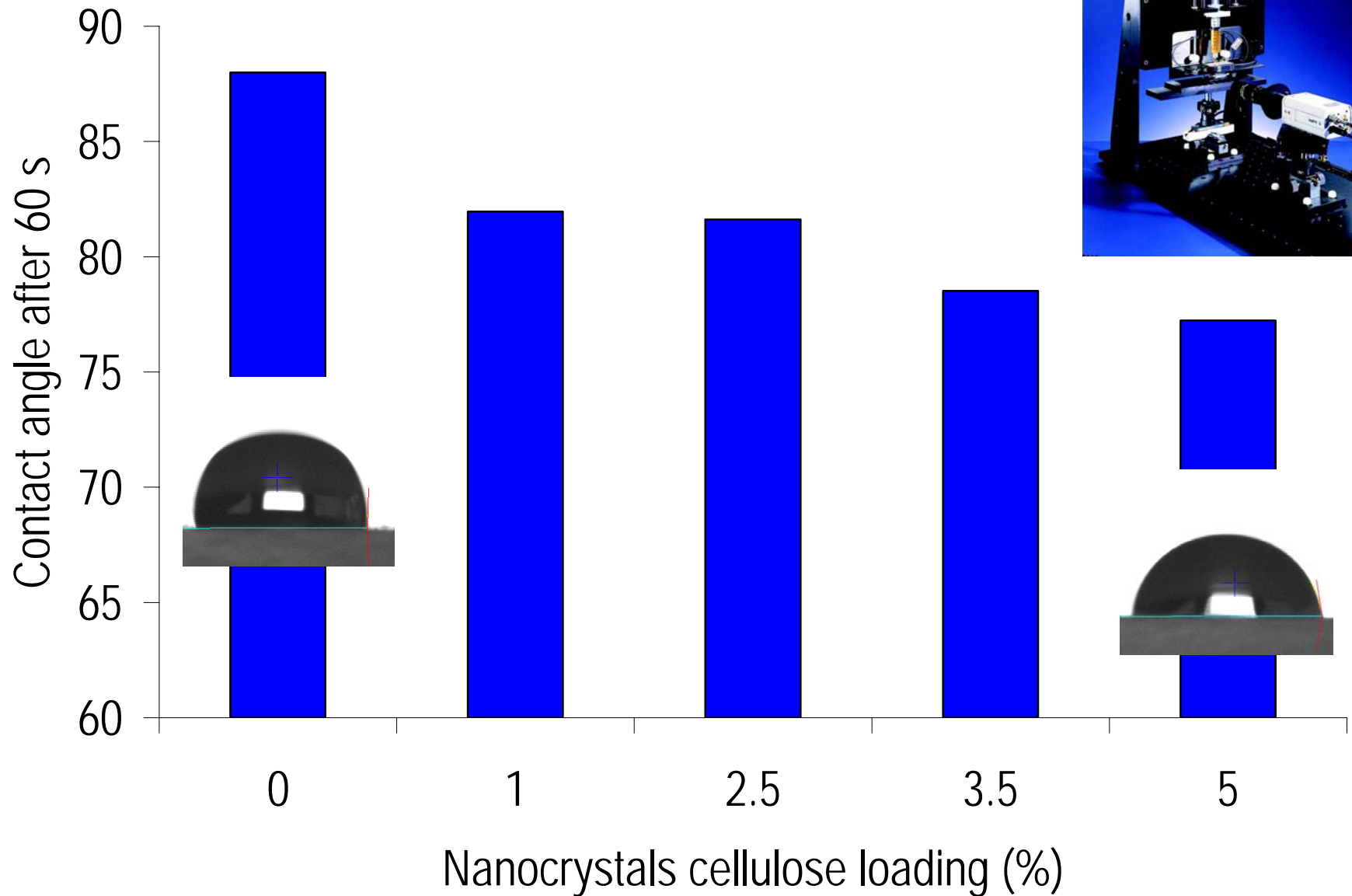
# Mechanical Characterization

## Hardness



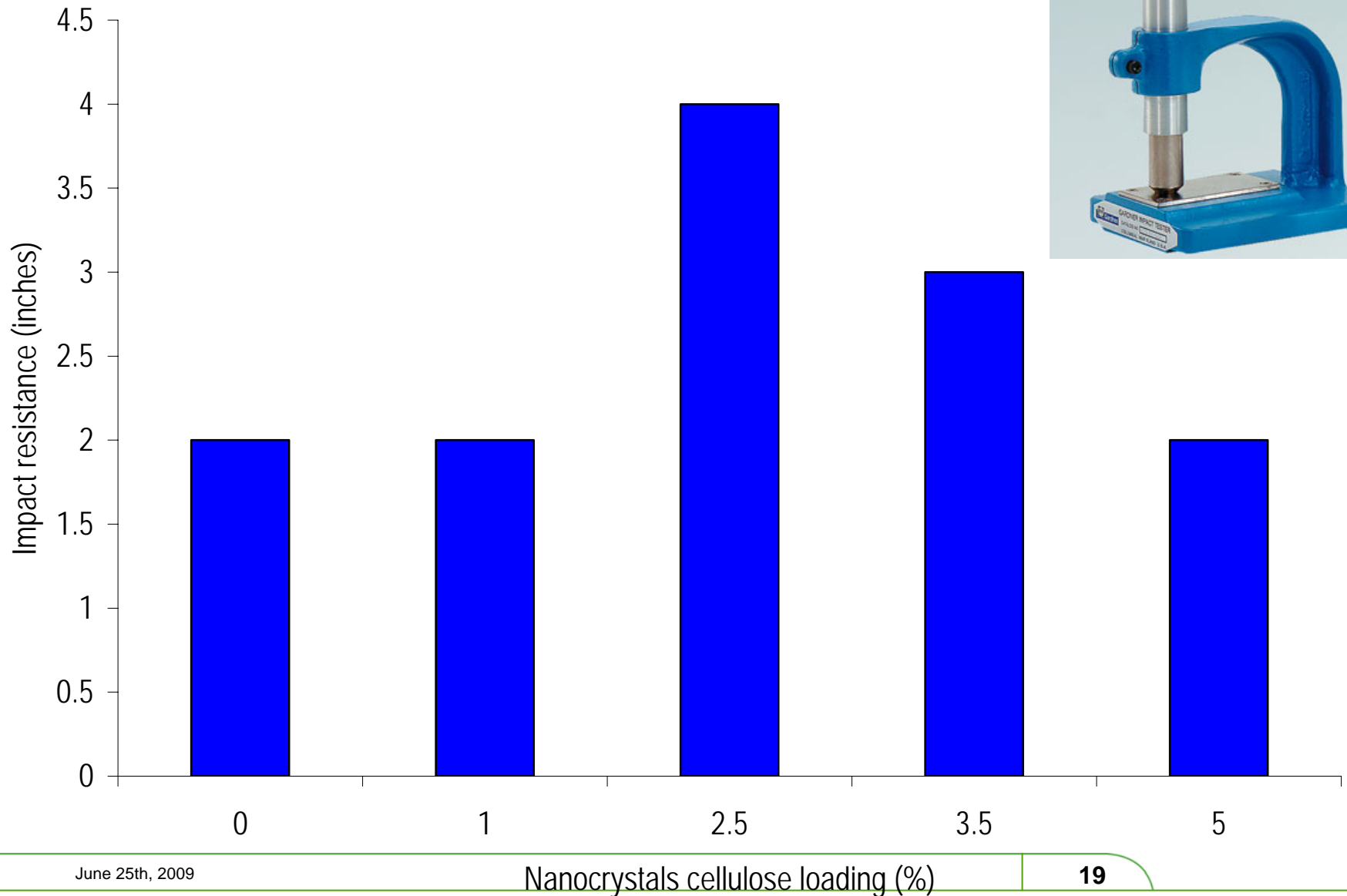
# Mechanical Characterization

## Wettability



# Mechanical Characterization

## Impact Resistance



# Second attempt : UV waterbased varnishes

- Relatively new technology
- Used in kitchen cabinets, furniture and other wood industries
- Can be used to replace UV high solids varnishes when health is a concern or when low viscosity UV coatings are necessary
- Chemical and mechanical performance is more important than for acrylic lacquers but lower than for UV high solids varnishes



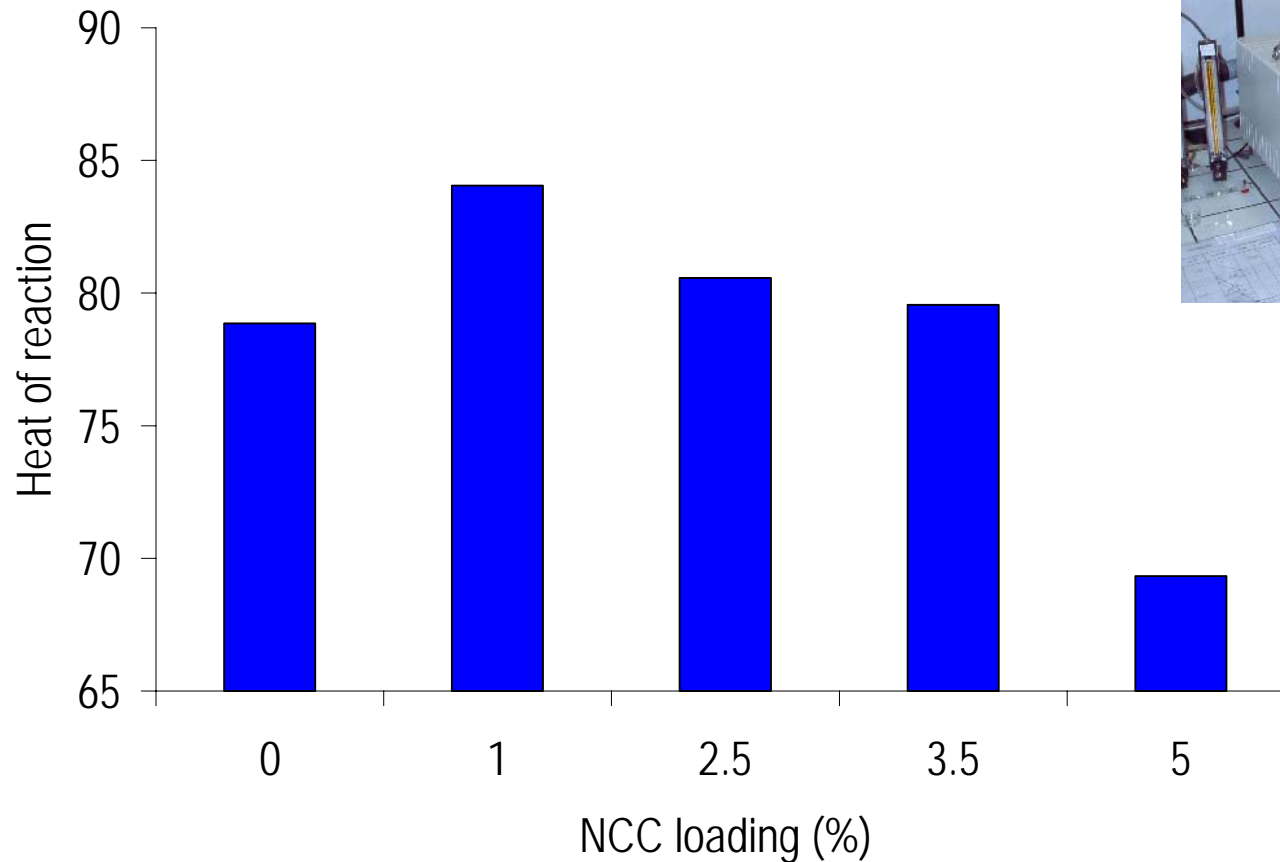
UV waterborne  
varnishes

Chemical and Mechanical Performance



# Curing efficiency

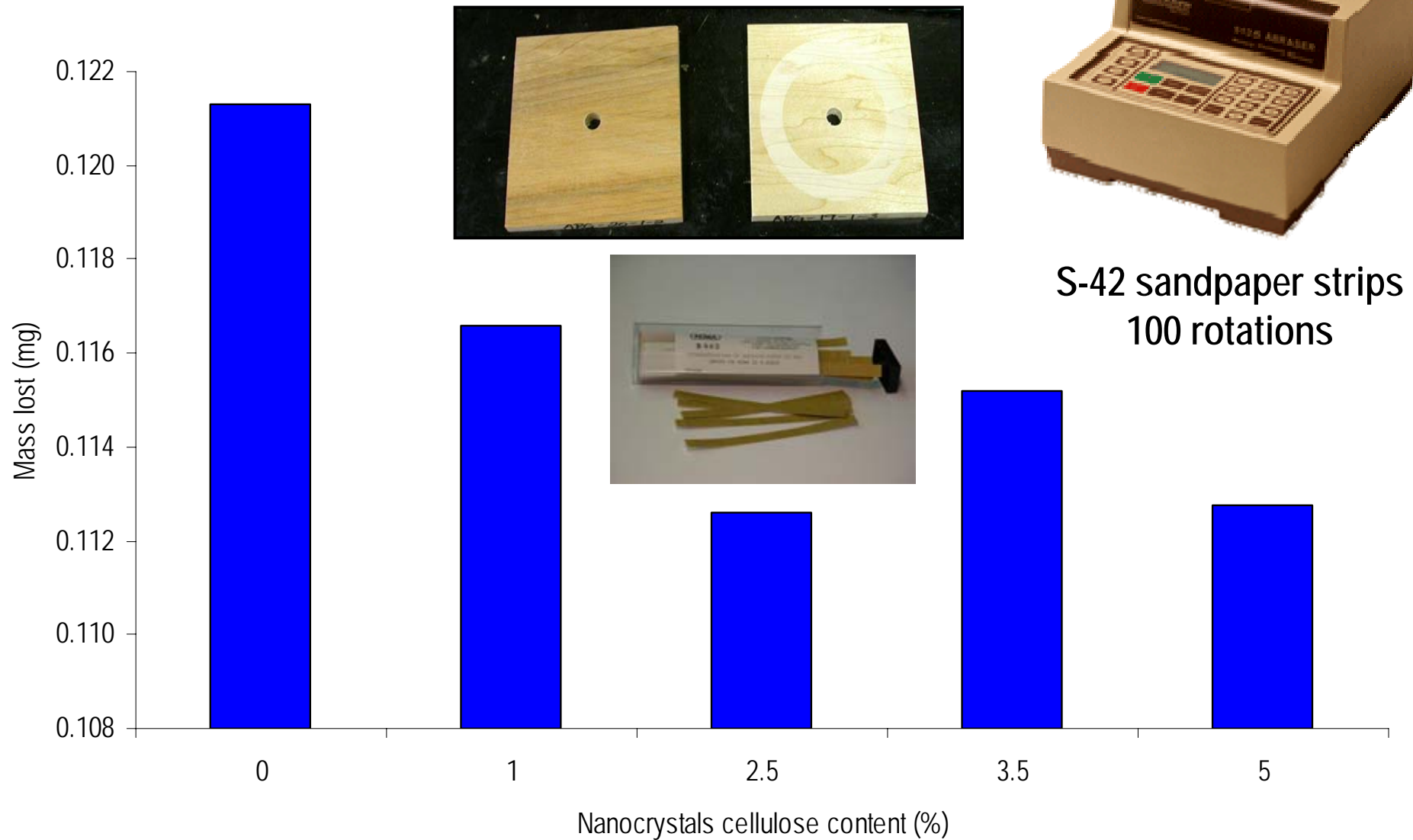
## Photo-DSC experiments



The heat of reaction is related to the degree of polymerization (extent of cure)  
Curing speed is also increased by the addition of 1, 2.5 and 3.5 wt% of NCC

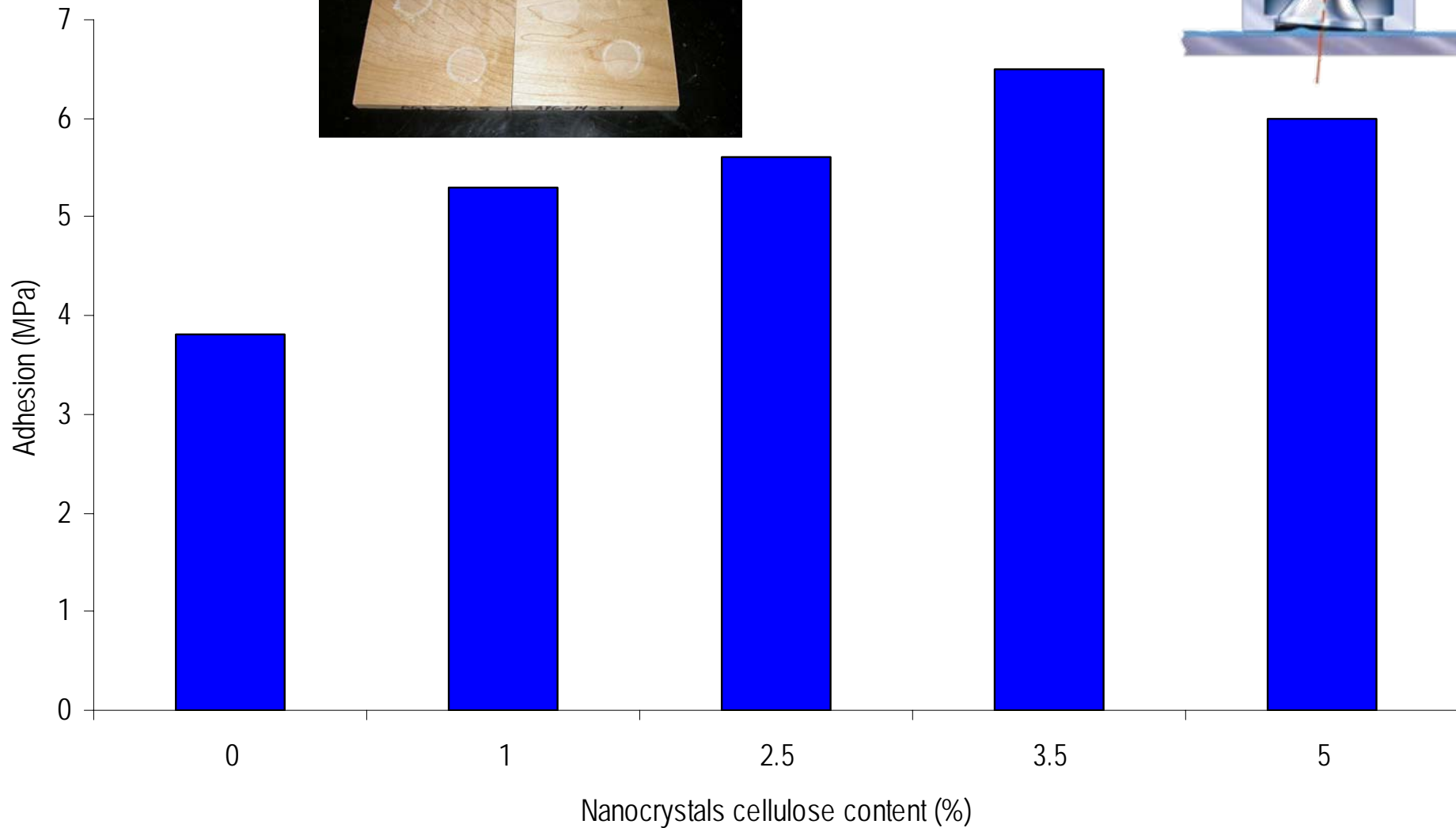
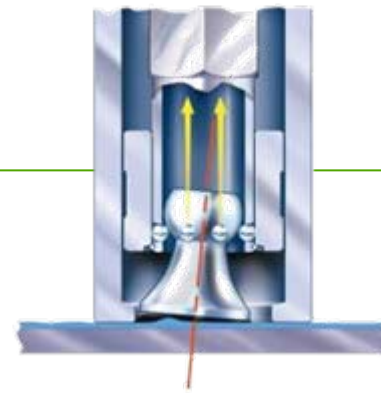
# Mechanical Properties

## Abrasion



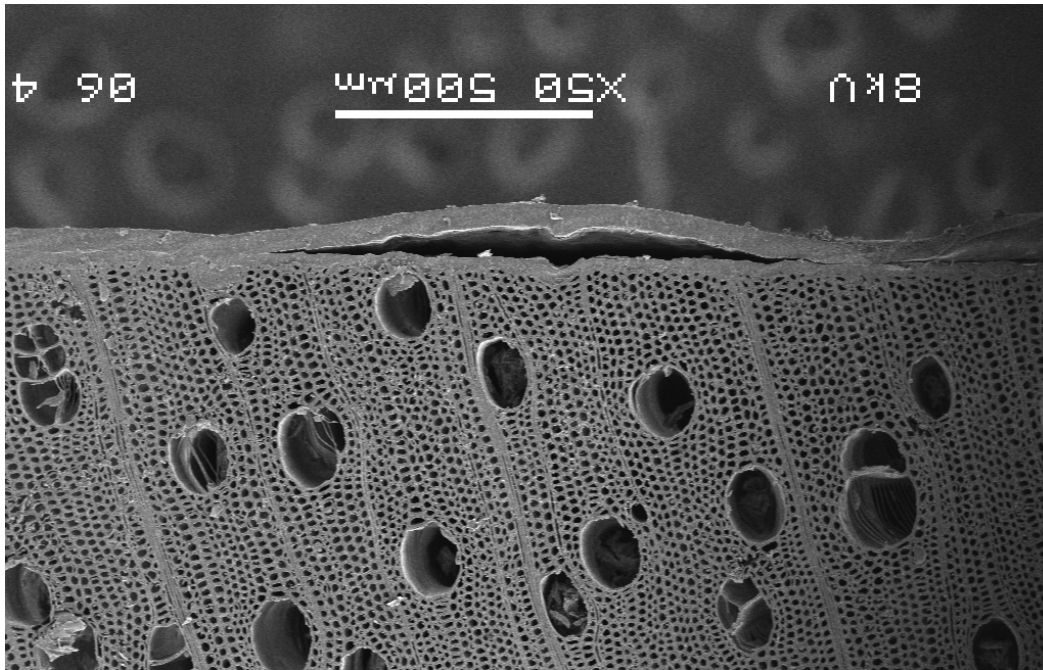
# Mechanical Properties

## Adhesion

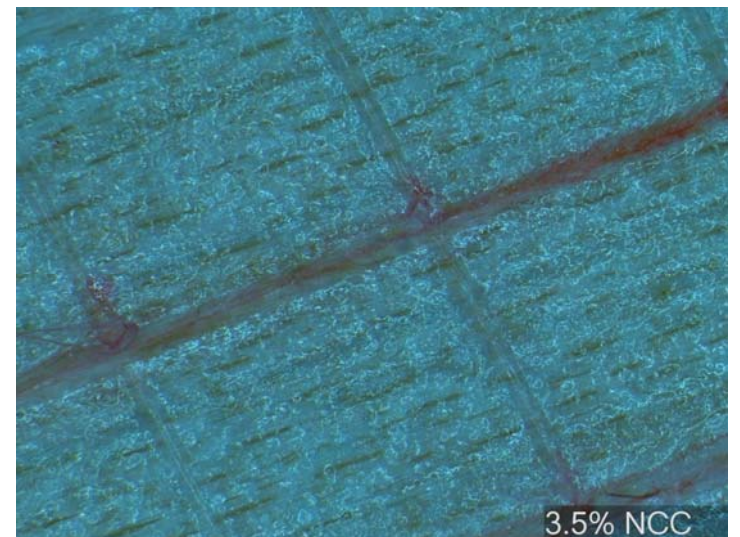
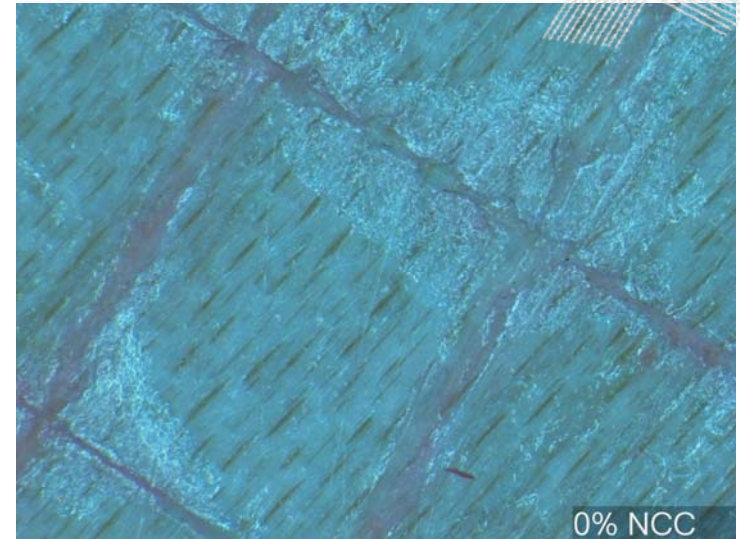


# Mechanical Properties

## NCC Improves the adhesion



SEM, 50X, UV Waterborne  
varnish without NCC



# Conclusions

- Previous studies found that the dispersion and the particle size of nanoparticles strongly influence mechanical and optical properties
- NCC improves the mechanical properties of acrylic lacquers and UV waterbased varnish:
  - Scratch Resistance
  - Abrasion Resistance
  - Impact Resistance
  - Hardness
  - Ect.
- Stability is still an issue
- Optical properties remain good



# Future Work

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- Work on stability
- Incorporation of NCC in UV high solids coatings

# Acknowledgements

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- FPInnovations
  - Greg Chauve
  - Tommy Martel
  - Ayse Alemdar
  - Pierre Blanchet
  - Jean Bouchard
- Akzo Nobel and Peintures Canlak