# LAYER BY LAYER MODIFICATION

CSILLA CSIHA

## COST FP 1006 WOOD SURFACE MODIFICATION WG1

chaired by Gerhard Grüll

Meeting of WG 1, Kuchl, 2014

- Layer by layer modification
- *In discussion in Lisbon it was not clear to audience what this item means/ intention. Should be clarified and newly discussed*
- *Presentation by Csilla Csiha*

- The layer-by-layer assembly (LbL) is a relatively new method by which thin films particularly of oppositely charged polyelectrolyte layers are deposited on surfaces
- Thin film layer-by-layer assembly technique can also be utilized for nanoparticles.

- **Advantages of layer-by-layer assembly technique:**

  - simplicity,
  - universality
  - thickness control at nanoscale.
  - the layer-by-layer assembly process does not require highly pure components and neither sophisticated hardware

- For almost all-aqueous dispersion of even high molecular weight species, it is easy to find an LbL pair suitable for building thin layer.

- In fact  in each adsorption step, we get either a monolayer or a sub monolayer of the species and therefore we can find the number of adsorption steps needed for a particular nanoscale layer.

- A variety of species and components are available for layer-by-layer assembly process and this has led to a growth in the LBL nanocomposites. Further organic-inorganic composites can act as functional groups and that can improve the performance of the material

- Scott Rennecar (Department of Wood Science and Forest Products and T. Brooks Forest Products Center, Virginia Tech, Blacksburg,Virginia 24061)

- Has done a fair amount of work with LbL coatings working with solid wood, wood fiber, and wood polymers.

- Most of their work is focused on understanding deposition conditions impacting the layering amount.  They do not have too much focus on the application of functional LbL films

- The Department of Wood Science and Forest Products and T. Brooks Forest Products Center, Virginia Tech team:

Scott Renneckar, Yu Zhou, Karthik V. Pillai, Qingqing Li, Zhiyuan Lin, W. Travis Church, Daniel P. Hindman

➡ **Layer-by-layer nanoparticle coatings on lignocellulose wood microfibers**

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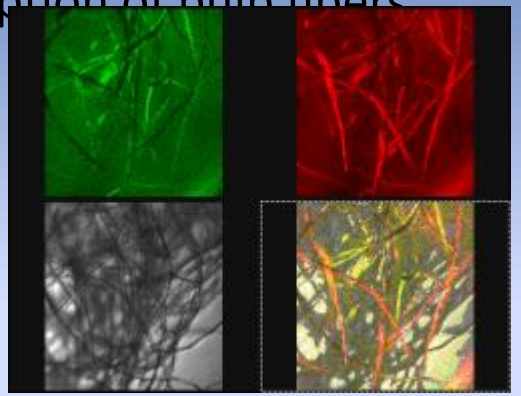
# RESULTS AT UWH

- At UWH in the Institute of Wood and Paper Technology LbL technique has been used and modified for molecular adsorption of pulp fibers:
  - tensile strength increased by 24%
  - dewatering rate increased by 4-8%
  - Brightness 4%, smoothness 40%



In the Institute of Product Development and Manufacturing preliminary tests done with NC laquers after PDDA/PSS, PDDA/PAH treatment resulted in a duplication of adhesion of the lacquer layer.

- Polycations: - poly(diallyl dimethylammonium chloride) (PDDA), a watersoluble cationic polyelectrolyte
  - poly(allylamine hydrochloride) (PAH)

- Polyanion: Polystyrene Sulfonate (Sodium Salt) (PSS)

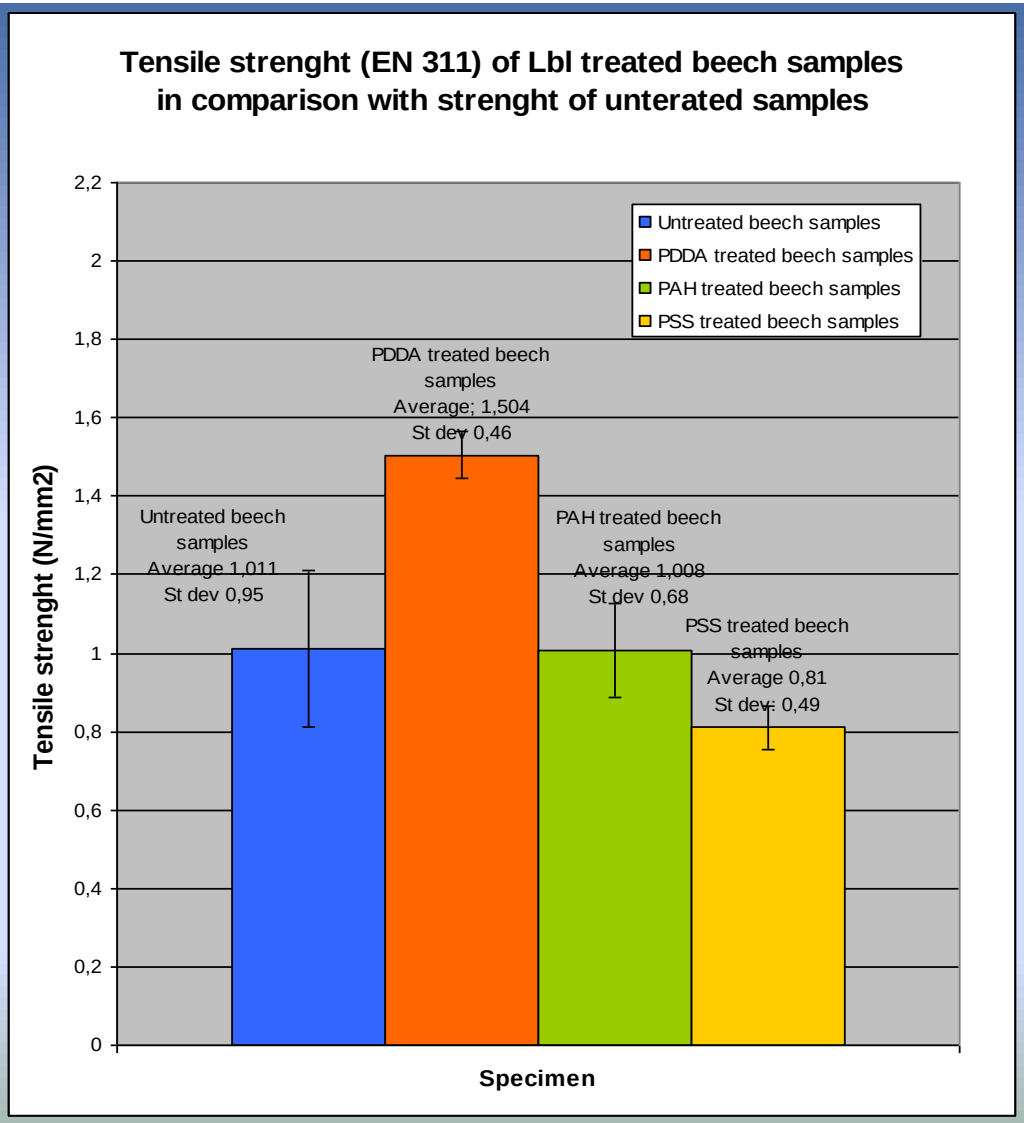
- The wood species : planed samples were prepared from
  Beech (Fagus silvatica)
  Scotch fir (Pinus silvestris)

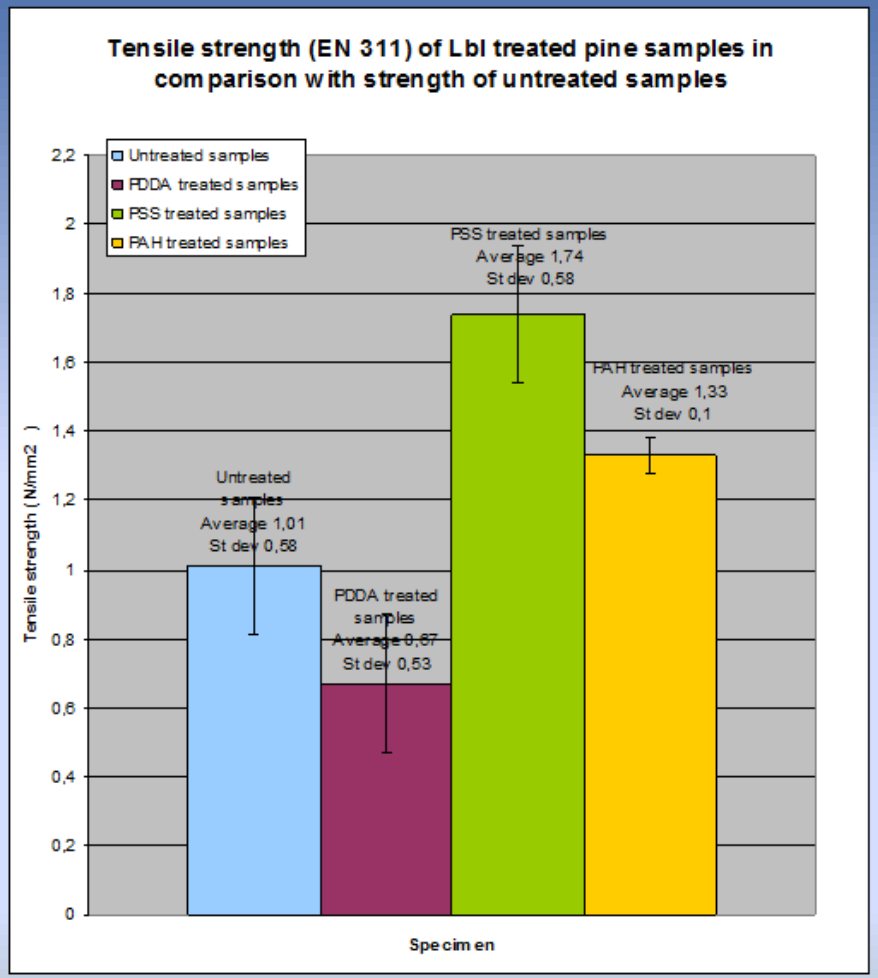
- The samples were treated by spraying alternatively with
- 1.) PDDA/PSS
- 2.) PAH/PSS
- 3.) PSS

- applying 22 layers, roughly resulting 100-120 nm layer thickness
- Untreated samples were prepared as well.

a common water-soluble PVAC dispersion adhesive

Delamination test were carried out on Instron 5566


Tensile strenght (EN 311) of Lbl treated beech samples in comparison with strenght of unterated samples
Tensile strenght (N/mm2)
2,2
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
Untreated beech samples
PDDA treated beech samples
PAH treated beech samples
PSS treated beech samples
PDDA treated beech samples Average; 1,504 St dev 0,46
Untreated beech samples Average 1,011 St dev 0,95
PAH treated beech samples Average 1,008 St dev 0,68
PSS treated beech samples Average 0,81 St dev 0,49
Specimen


Tensile strength (EN 311) of Lbl treated pine samples in comparison with strength of untreated samples
Untreated samples
PDDA treated samples
PSS treated samples
PAH treated samples
2,2
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
Tensile strength ( N/mm2 )
Untreated samples
Average 1,01
St dev 0,58
PDDA treated samples
Average 0,67
St dev 0,53
PSS treated samples
Average 1,74
St dev 0,58
PAH treated samples
Average 1,33
St dev 0,1
Specimen

- A message from Dr. Scott:

  „there is a lot of work out there”