COST FP1303
Sofia, Bulgaria
02.28 - 03.01
2017

Decreasing the hygroscopicity of wood with nanoparticles

MIKLÓS BAK

FERENC MOLNÁR

University of Sopron
Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts

Introduction

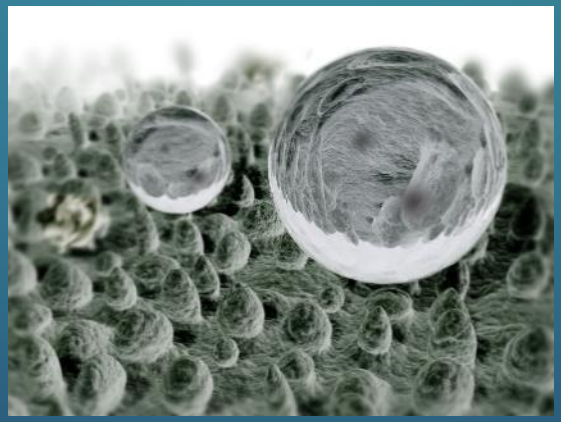
About nanotechnology

- Preparation and research of materials and tools in the range of one to maximum several hundreds of nanometers
- The objective is to modify the material properties by its size and determine the effect of these modifications

Introduction

About nanotechnology

- Nanomaterials have several specific property, which is determined – beyond their chemical composition – by the specific properties of their components and its colloidal structure (size effect of nanoparticles)
- These specific properties exist only in the nano-scale

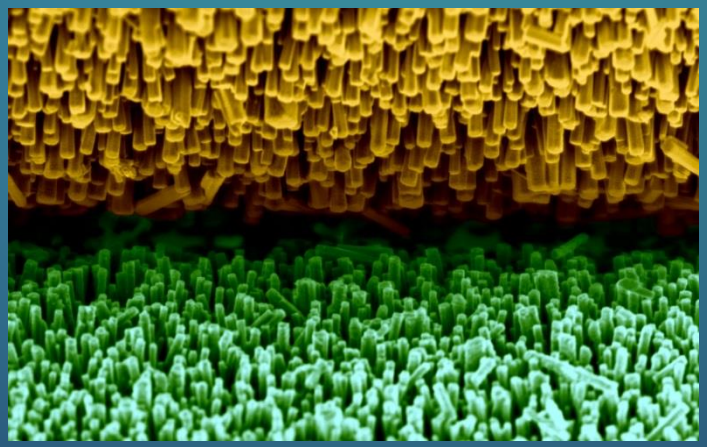


https://commons.wikimedia.org

Introduction

About nanotechnology

- With the decreasing size, the physical and chemical properties of the particles are changing remarkably
- Important difference is the significantly increased specific surface area



nanotech.uiowa.edu

Introduction

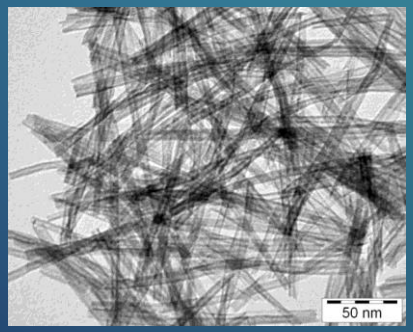
Nanotechnology in wood science

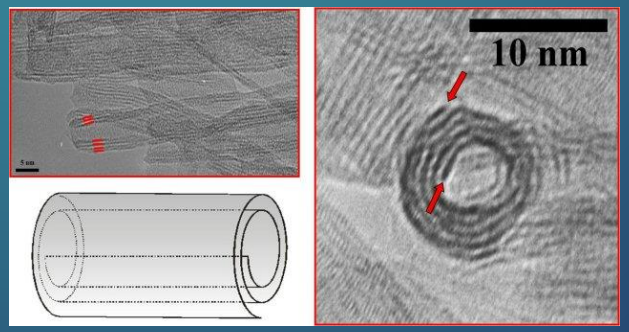
- Nanotechnology has the potential to show off good results in wood science and technology, by producing new active agents and mode of actions
  - Surface coatings
  - Direct modification of wood
- Different utilization fields:
  - UV-protection
  - Wood preservation
  - Decreasing the hygroscopicity

Materials and methods

Hydrophobe Titanate NanoTube (HTNT)

- TiO_2 nanoparticles are well known in several industries (paints, cosmetics, etc.)
- TNT-s are produced by hydrothermal recrystallization of nanoparticels
- Hydrophobation by ion exchange
- Diameter is 5-8 nm, length is 100-500 nm
- Rigid and layered structure (4-5 layer)
- Manufacturer: Nanobakt Kft. (Hungary)



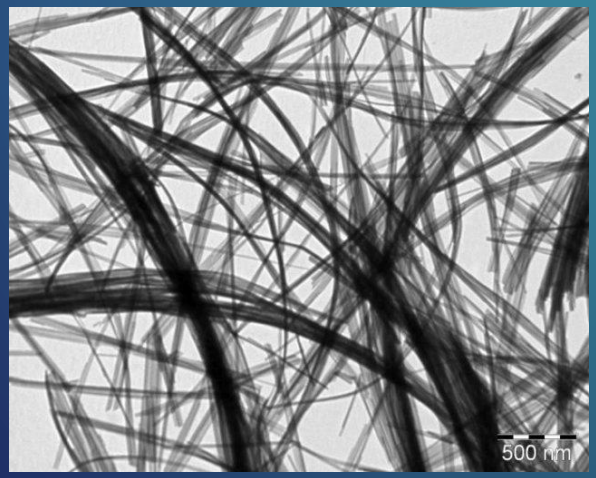


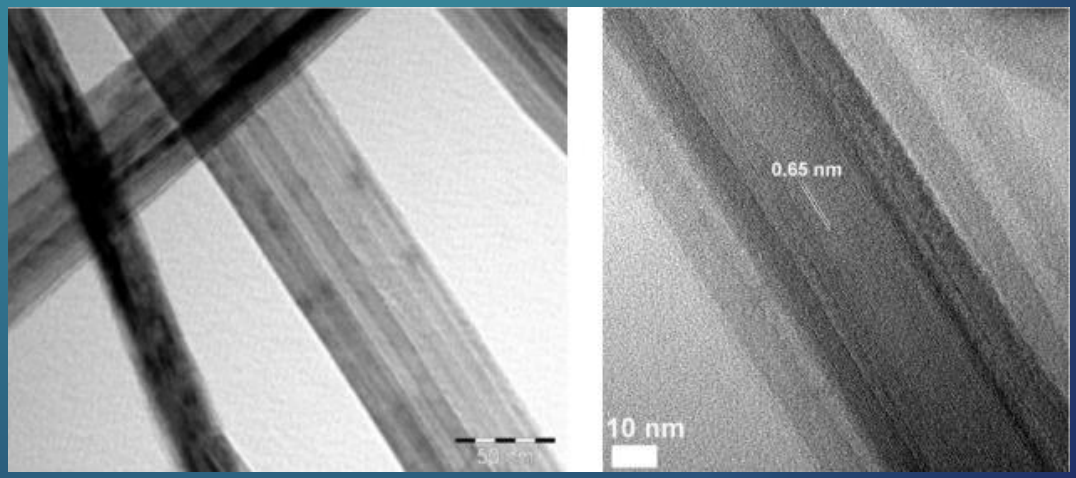
Nanobakt.hu

Materials and methods

Hydrophobe Titanate NanoWire (HTNW)

- TNW-s are produced by a modified hydrothermal recrystallization of nanoparticels
- Hydrophobation by ion exchange
- Diameter is 50-100 nm, length is 1-10 µm
- Slightly flexible and layered structure (50-100 layer)
- Manufacturer: Nanobakt Kft. (Hungary)





Materials and methods

Test methods

- Investigated wood species:
  - Beech (*Fagus sylvatica*)
  - Poplar (*Populus* × *euramericana* cv. Pannonia)
  - Pine (*Pinus sylvestris*)
  - Scpruce (*Picea abies*)
- Treatment of wood material by impregnation
  - Vacuum: 100 mbar, 60 min
  - Atmospheric pressure, 120 min
  - 2 different concentrations: 1% and 2%
  - 2 different nanoparticles

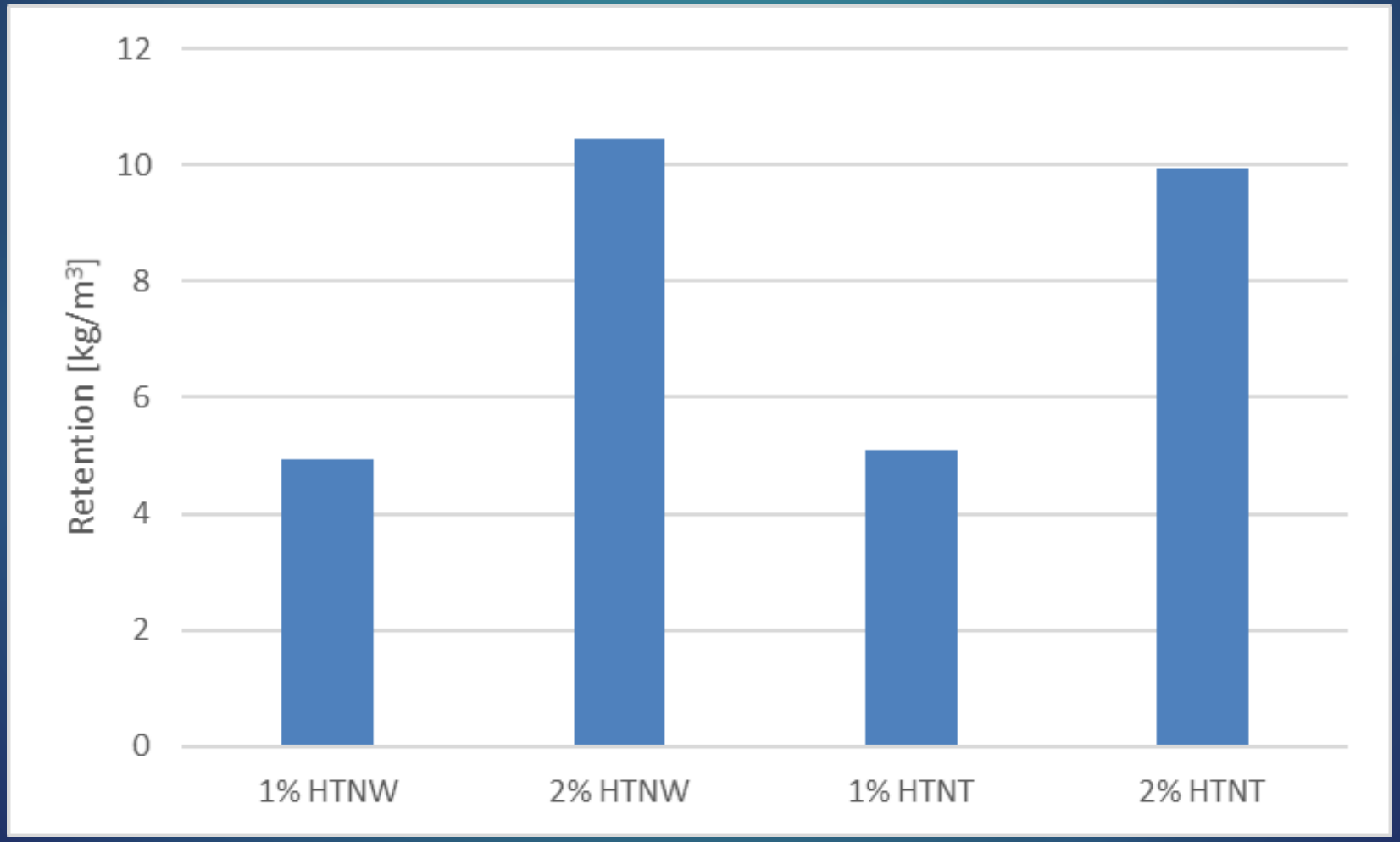
Materials and methods

Test methods

- Retention
- Colour change (CIELab)
- Shrinking coefficient (radial/tangential)
  - Impregnation → climatization → *drying* →
- Swelling coefficient (radial/tangential)
  - → d*rying* → immersion to water (7 days)
- Water uptake (EN 927-5)
  - radial/tangential surface
- Equilibrium moisture content (EMC)

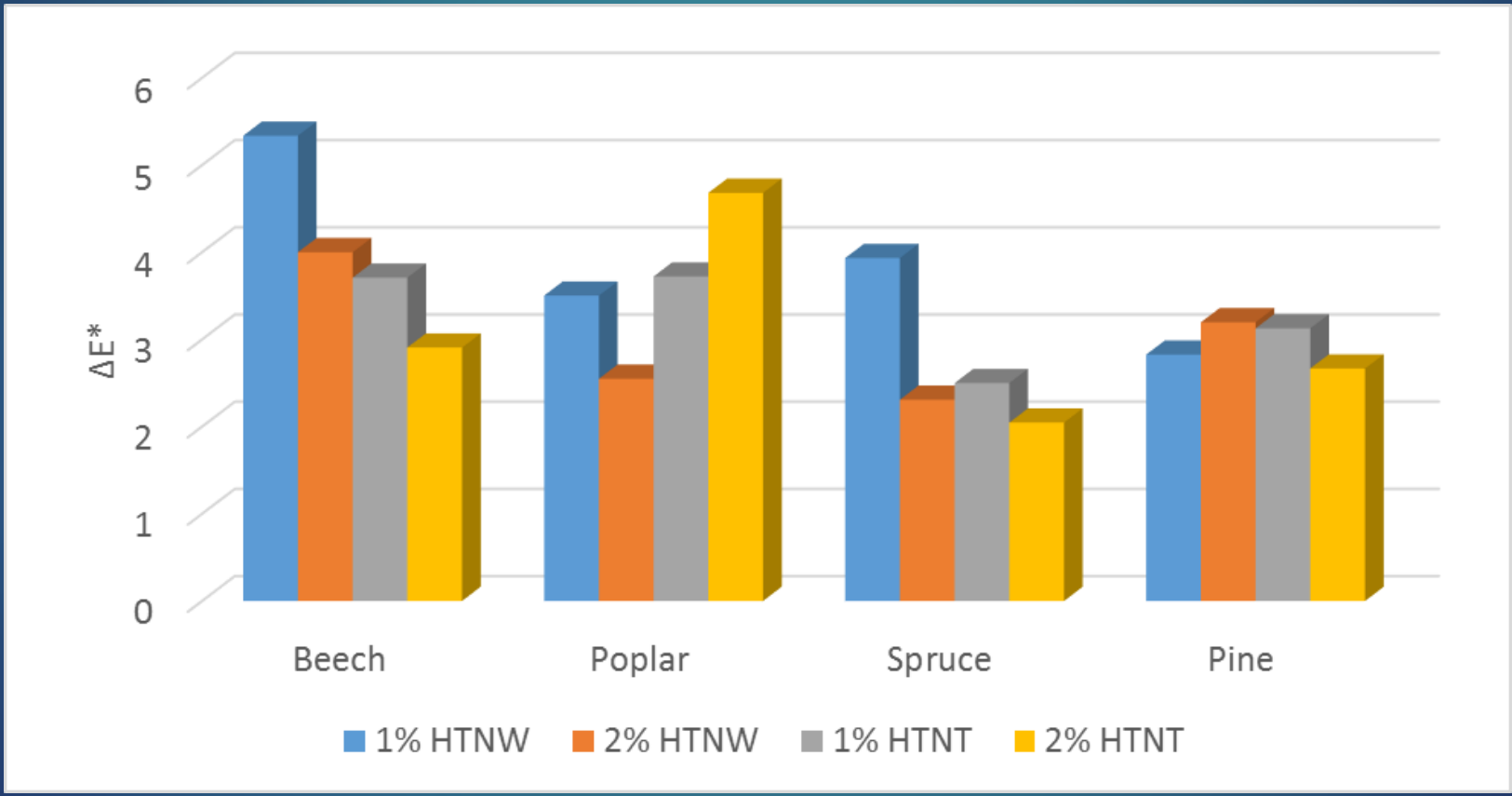
Results

Retention (Pine)



Results

Colour change

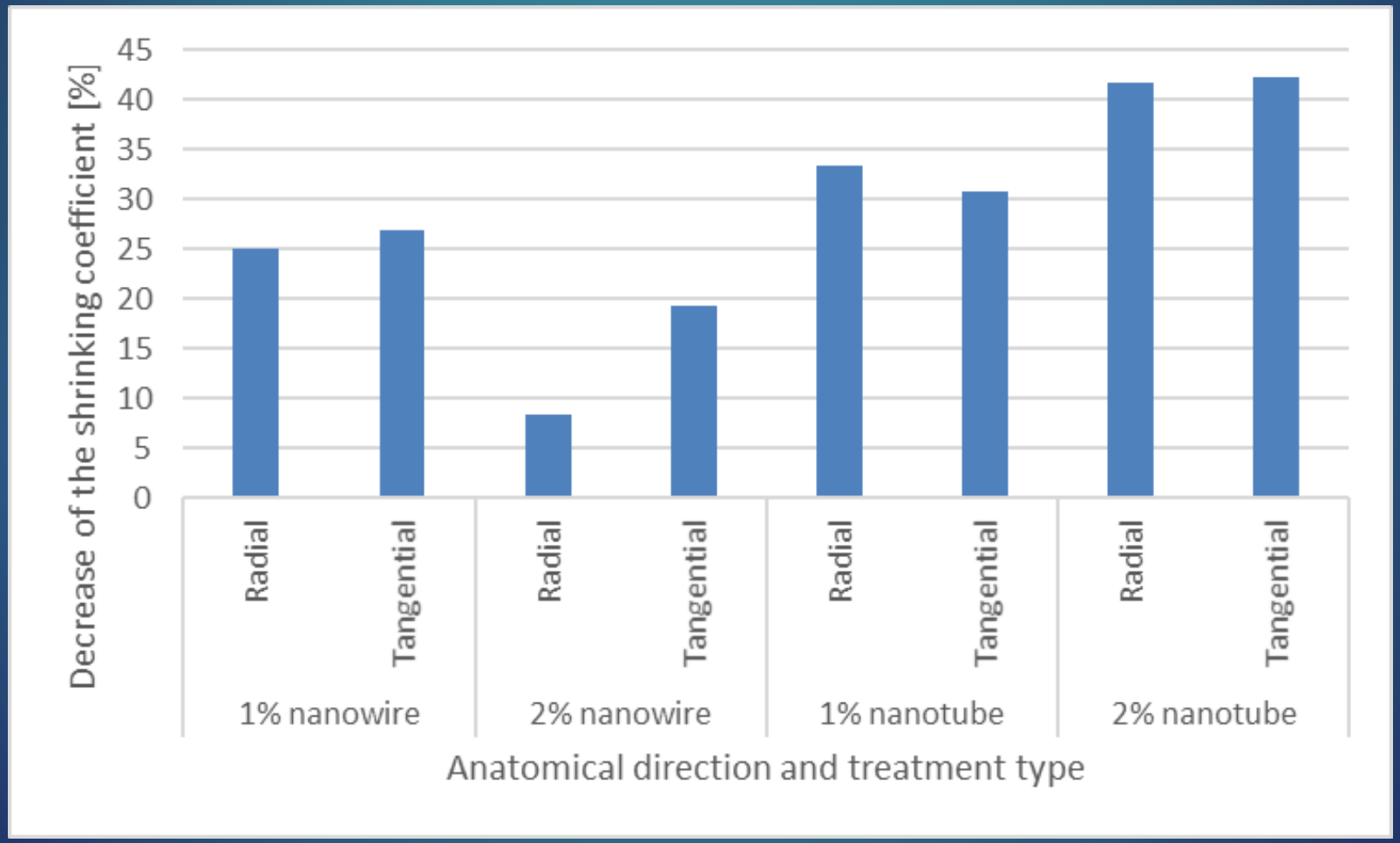


Results

Colour change

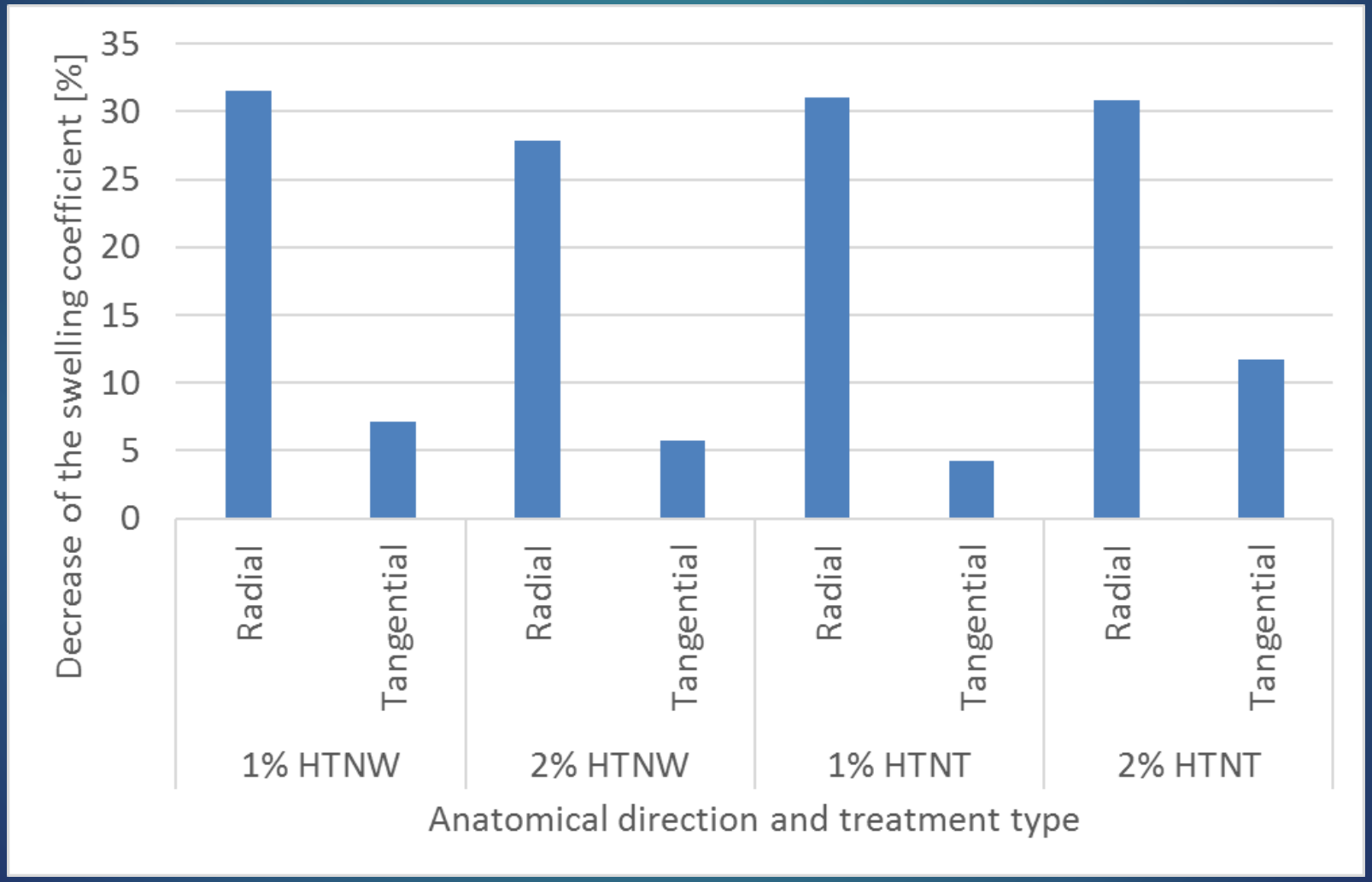
Results

Shrinking (Beech)



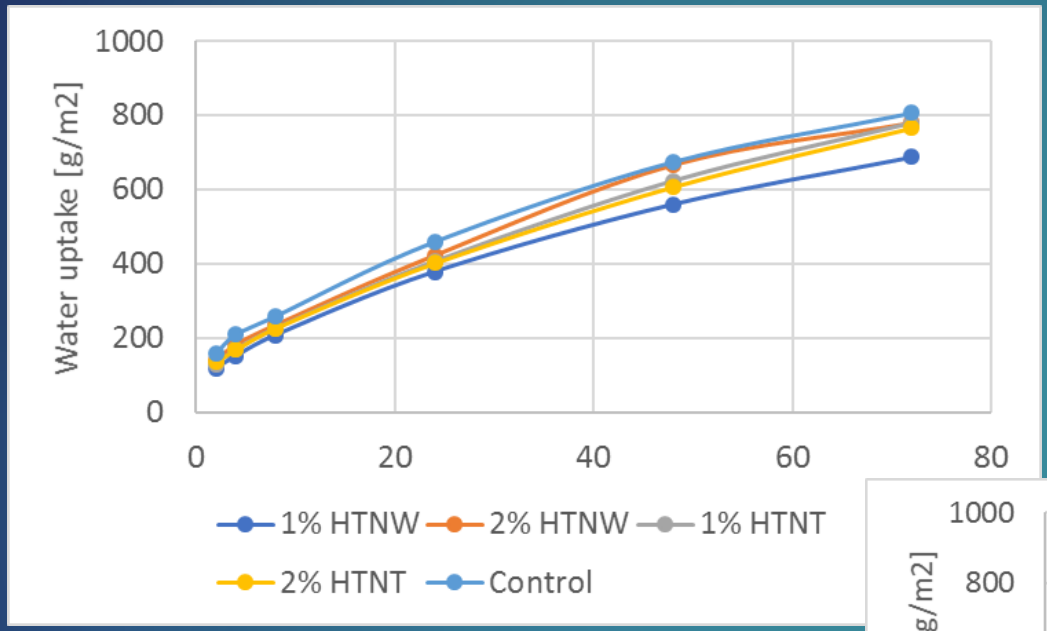
Results

Swelling (Beech)



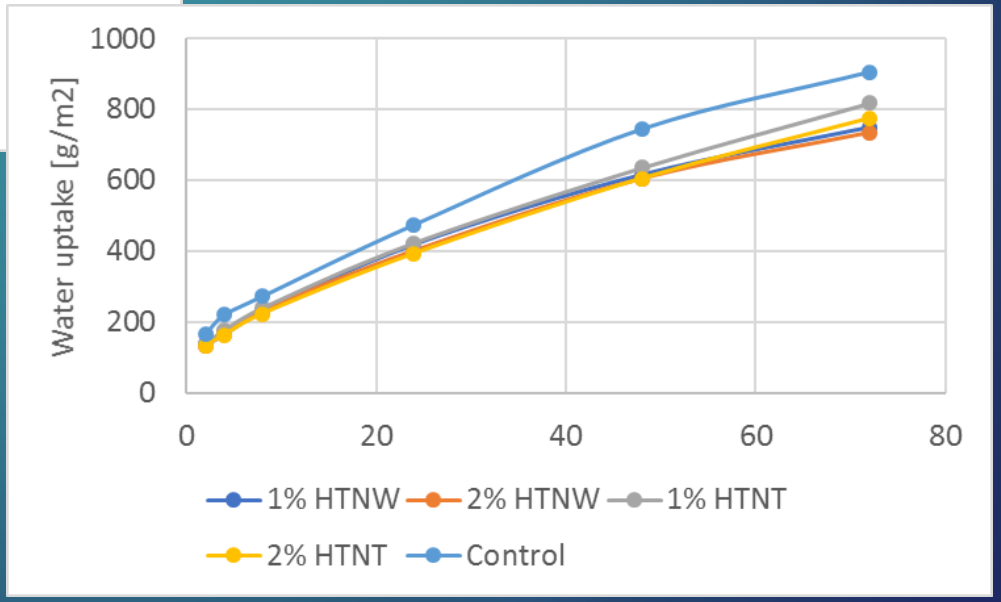
Results

Water uptake (Spruce)



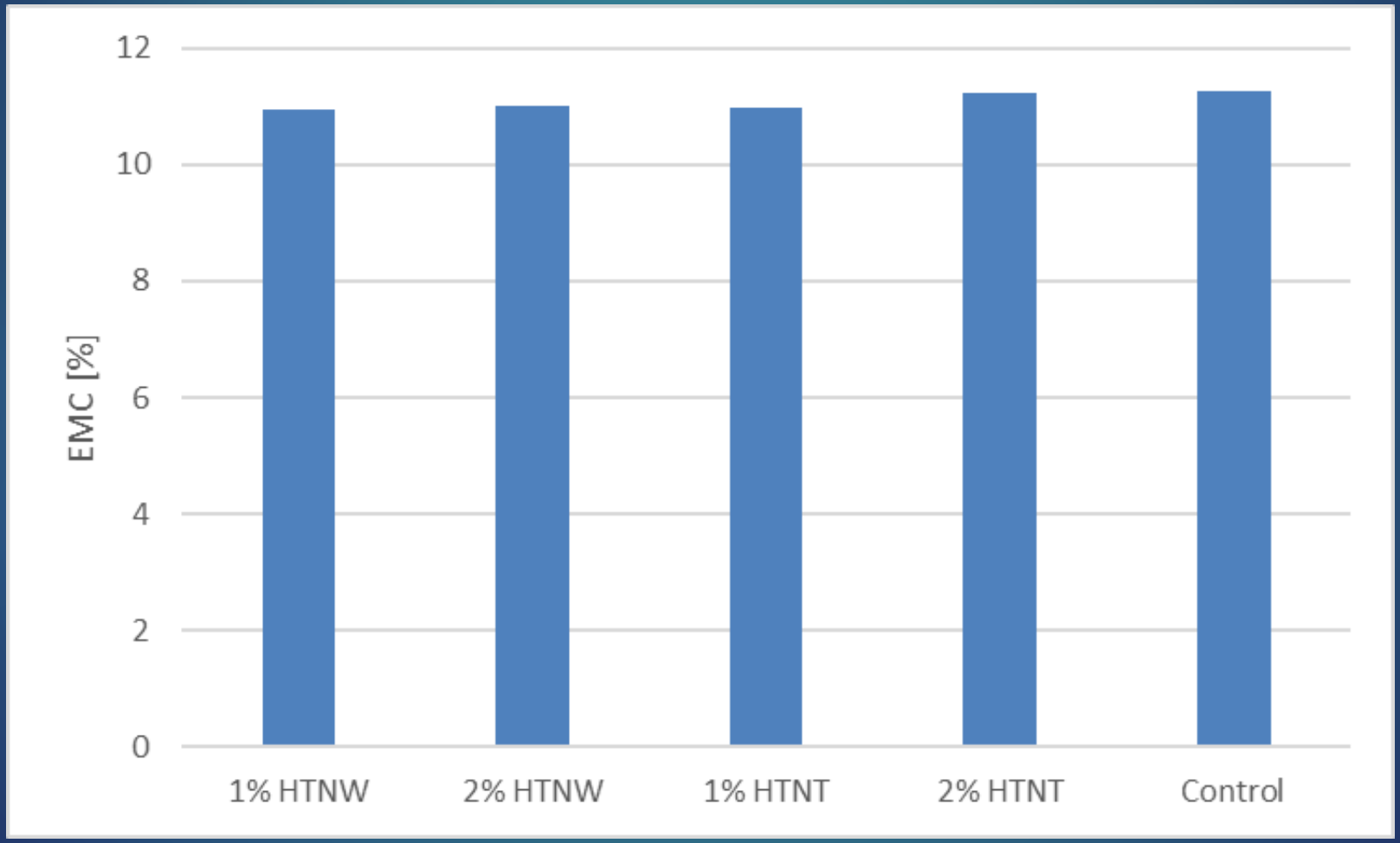
Radial surface

Tangential surface



Results

Equilibrium Moisture Content (Pine)



Conclusions

- Slight colour change (whitening, fading)
- 5-30% decrease in the swelling coefficient → anatom. dir. → fixation?
- 20-40% decrease in the shrinking coefficient
- Slight decrease in the water uptake (max. 10-15%)
- No change in the EMC
- Possible bulking of the cell wall

Acknowledgement

- Acknowledgments: This research was supported by the National Research, Development and Innovation Office - NKFIH, in the framework of the project OTKA PD 116635 with the title "Improvement of the most important wood properties with nanoparticles".

Thank you for your attention!