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Innovative Cellulose Products

THE EFFECT OF NANO CELLULOSE ADDITION ON THE PROPERTIES OF WATER-BASED POLYVINYL ACETATE PAPER ADHESIVE

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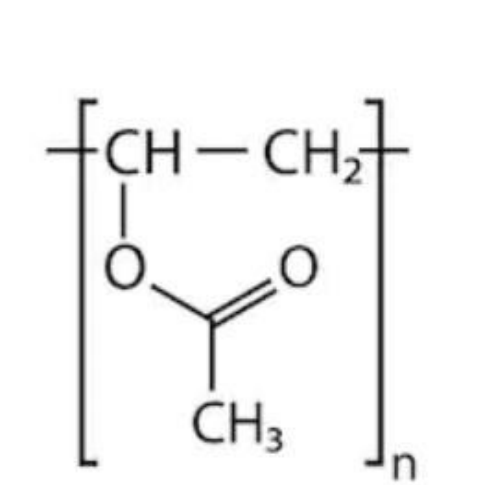
ADVANTAGES OF WATER-BASED POLYVINYL ACETATE ADHESIVES

- widely used in paper, wood and graphical industry
- environmentaly friendlier than solvent based
- no harmful substances (such as formaldehyde) are released
- simple application
- low cost and availability
- made by polymerisation of the vinyl acetate monomer

BASIC POLYMER UNIT



Polyvinyl Acetate
$(C_4H_6O_2)_n$

THE TESTED PVAc ADHESIVES

Adhesive for paper and cardboard, paper bags and suitable for bookbinders and graphical industry

Adhesive for paper and cardboard, transport packaging and paper bags

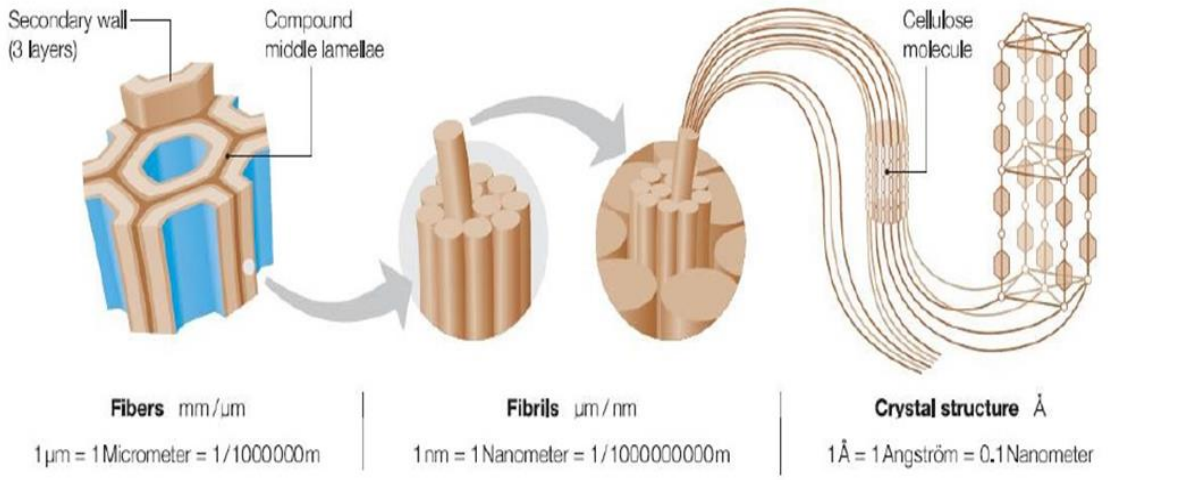
- The difference between them: MEKOL 1413/G forms more elastic film after drying

PVAc ADHESIVES PROPERTIES GIVEN BY PRODUCER

Water dispersion of polyvinylacetate polymer forms transparent film after drying

PROPERTIES	MEKOL 1301/1	MEKOL 1413/G
Colour	WHITE	WHITE
Viscosity [mPas]	1.700 - 2.200	15.000 - 22.000
Solid content [%]	50	46,5

NANOCELLULOSE



Scheme of cellulose/fibers/fibrils/crystal structure

Application for different end uses:

- Additives for paints, pigments, inks and adhesives
- Composite materials
- Nonwovens
- Paper and board as a filler or as an additive in coating color
- Food products
- Filter materials
- Cosmetics etc.

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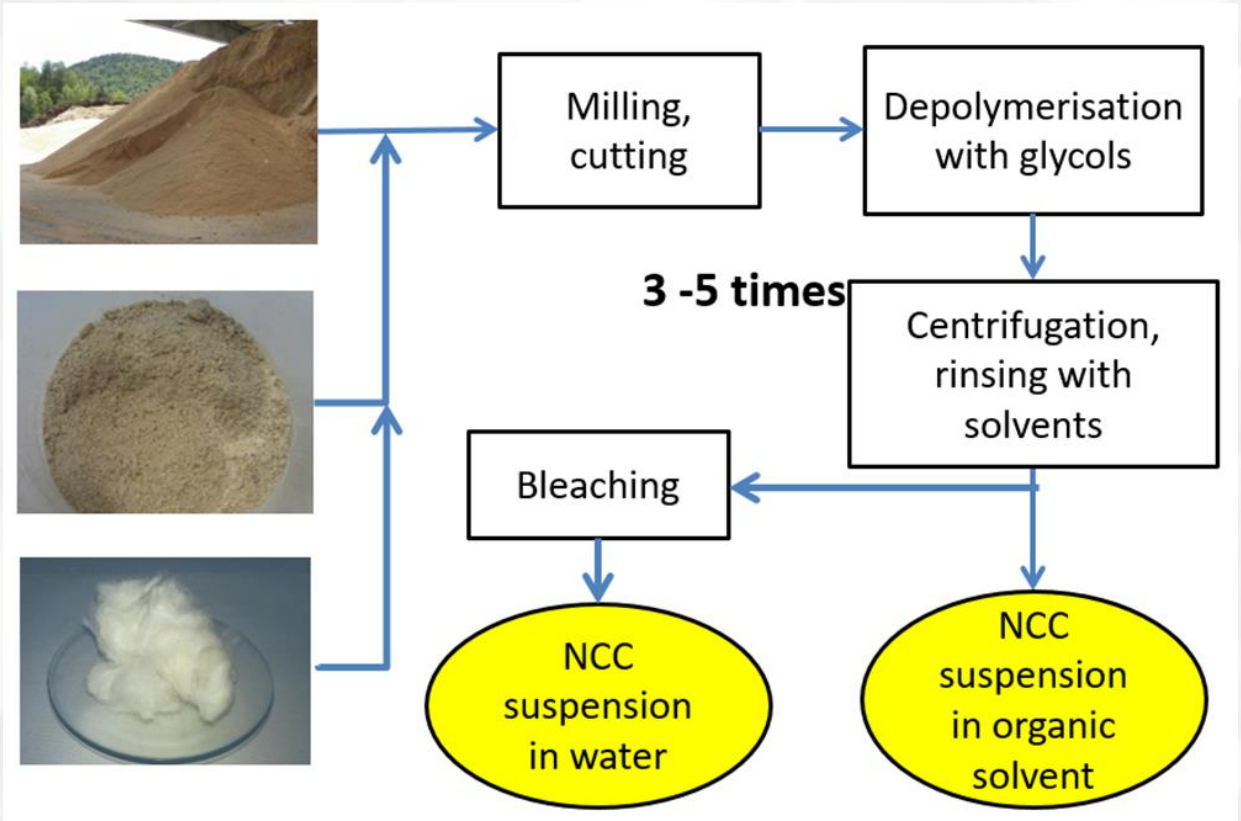
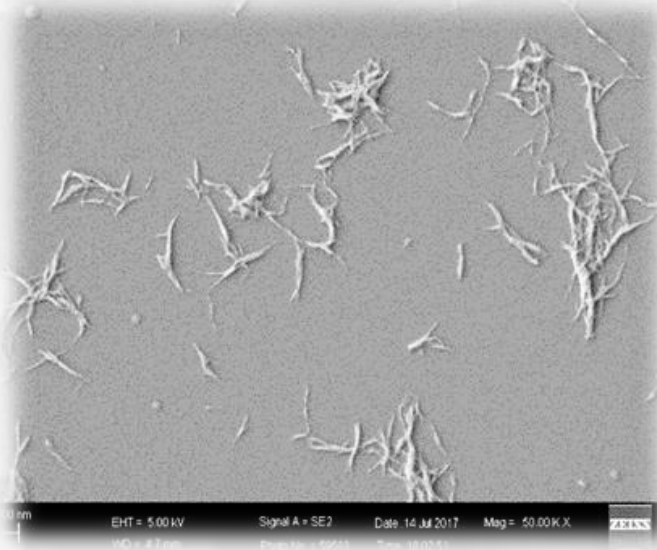
NANOCRYSTALLINE CELLULOSE FROM KI



Needle form
Solid content: 8 %

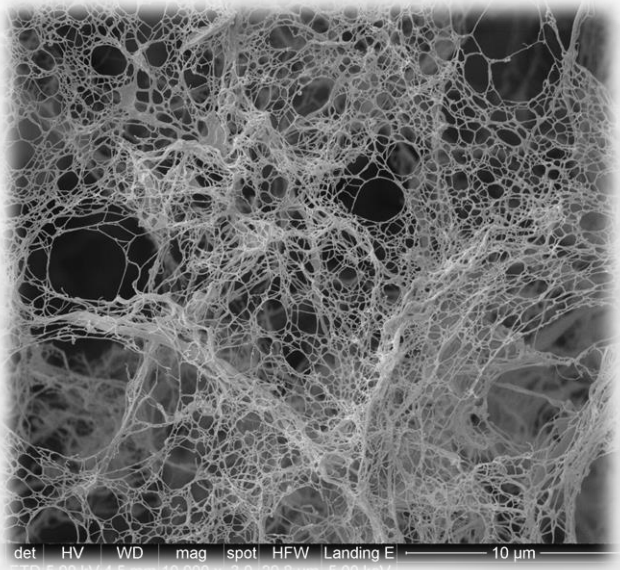
Diameter: 10-20 nm
Length: 40-200 nm
Crystallinity: 65 % to 90%



→ NANOCRYSTALLINE CELLULOSE WAS PRODUCED BY KI

NANOFIBRILLATED CELLULOSE (COMMERCIAL)

- Fibre form
- High specific surface
- Nanofibrils in at least one dimension less than 100 nm
- Solid content: 4 %
- Diameter: 10-200 nm
- Length: ≤50 µm



https://miro.medium.com/max/4200/0*ODJG_5d71yUb3c7-

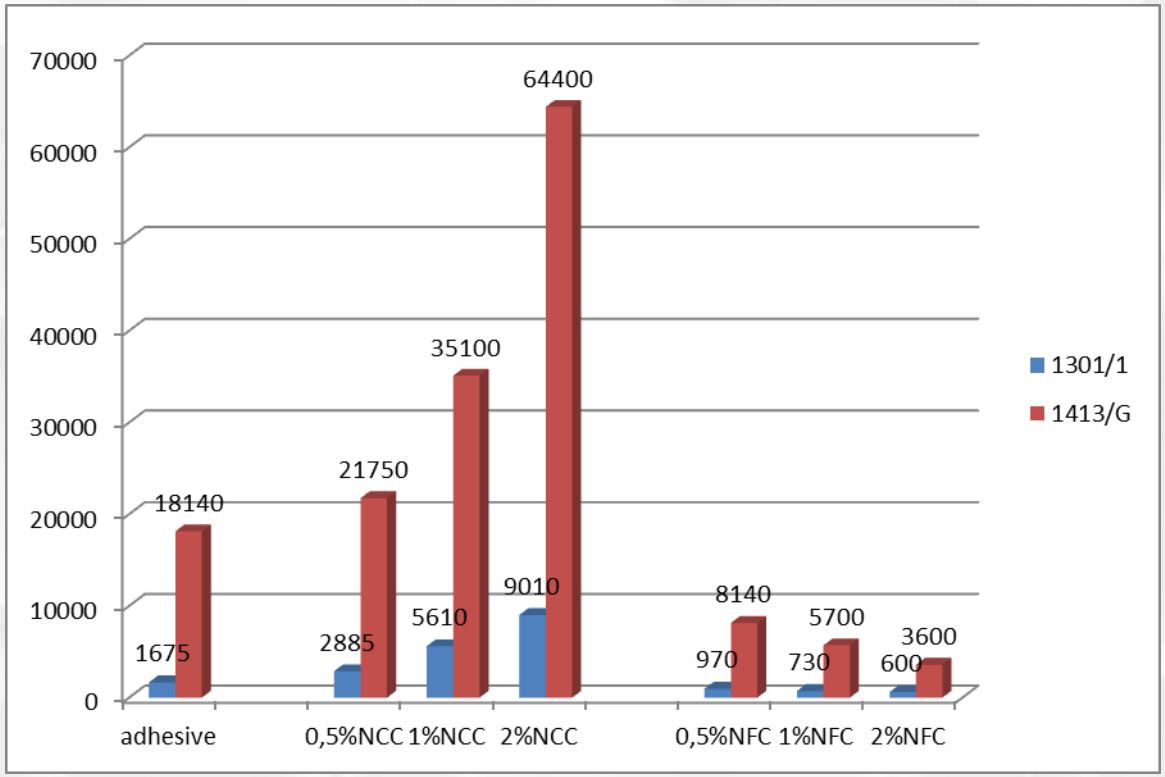
ADHESIVES MODIFICATIONS

Three diferent amounts [wt %] of nanocellulose were added to the adhesive:

- 0,5 %,
- 1 %
- 2 %

- Mixed with disperser for 5 minutes
- Mixing speed: 1500 rpm

VISCOSITY [mPas] OF MODIFIED PVAc ADHESIVES



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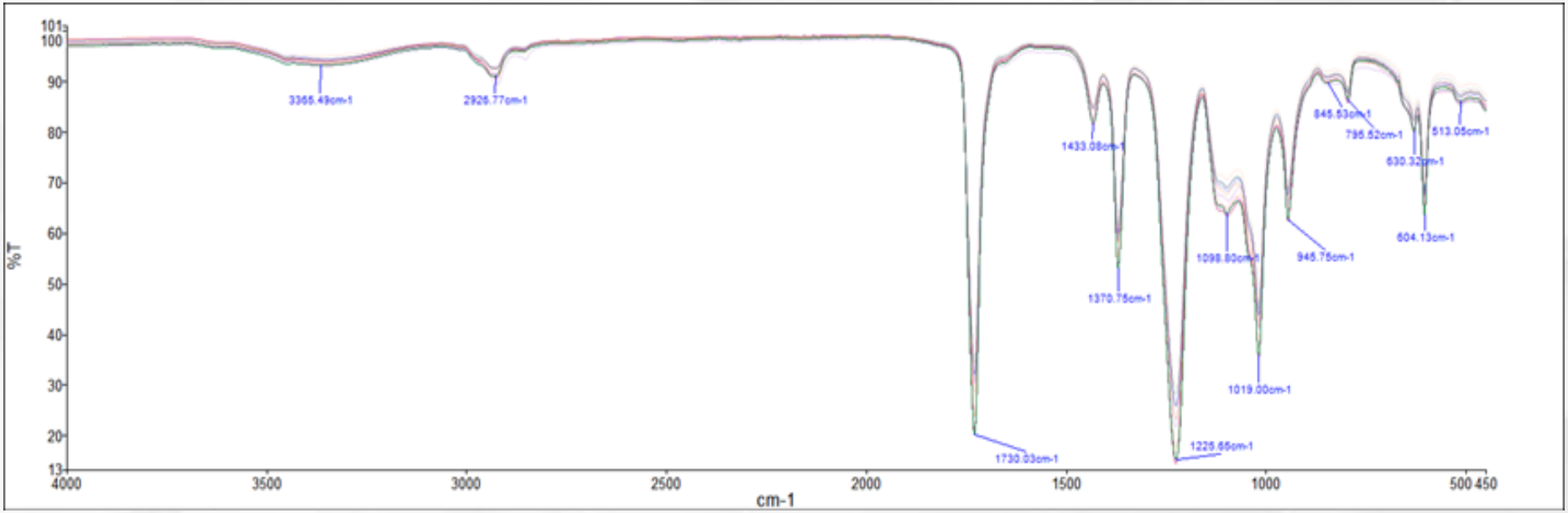
FTIR SPECTRA OF THE ADHESIVE SAMPLES



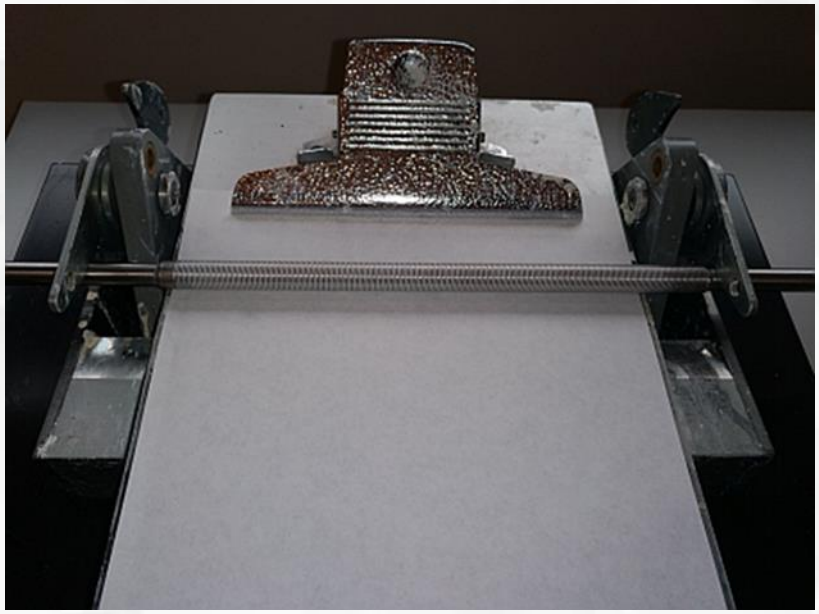
- Dry adhesive film on the glass plate.
- FTIR Spectra are typical for PVAc adhesives.
- No significant differences between samples.

PAPER PROPERTIES

Mechanical properties of the paper (substrat) were tested

PARAMETER	STANDARD	UNIT	RESULT [MD/CD or U/D]
Grammage	SIST EN ISO 536	g/m²	52,0
Thickness	SIST EN ISO 534	µm	80,5
Roughness PPS	ISO 8791-4	µm	5,63/5,84
Tearing resistance (tear index)	SIST EN ISO 1974	mNm²/g	9,43/9,47
Bursting strength (burst index)	SIST EN ISO 2758	kPam²/g	3,04/3,08
Tensile properties (tensile index, stretch at break, breaking length)	SIST EN ISO 1924-2	Nm/kg, %, km	60,5/34,0 1,5/4,3 and 6,2/3,5
Air permeability according to Bendtsen	SIST ISO 5636-3	ml/min	1776,8/1710,9
Air permeability according to Gurley	ISO 5636-5	s	6,72/7,05
Roughness Bendtsen	ISO 8791-2	ml/min	419,5/472,2

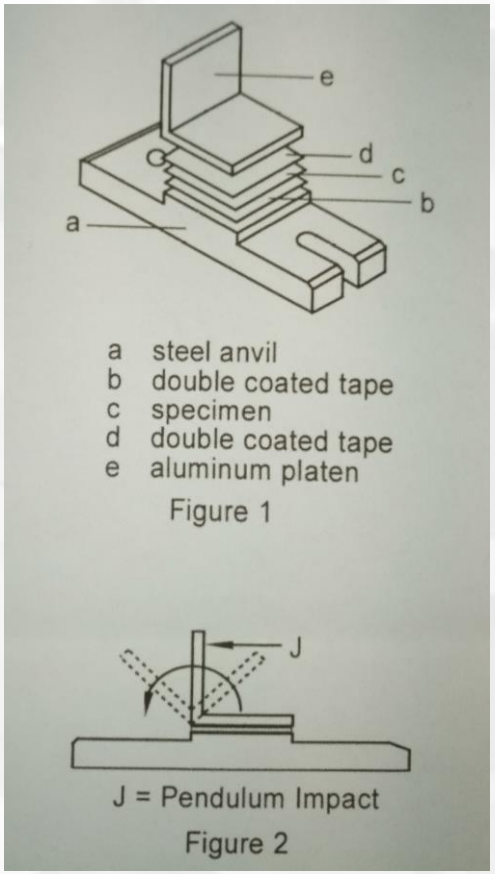
ADHESIVE COATING AND PAPER LAMINATING



Average grammage of coated dry adhesive was 17 g/m²

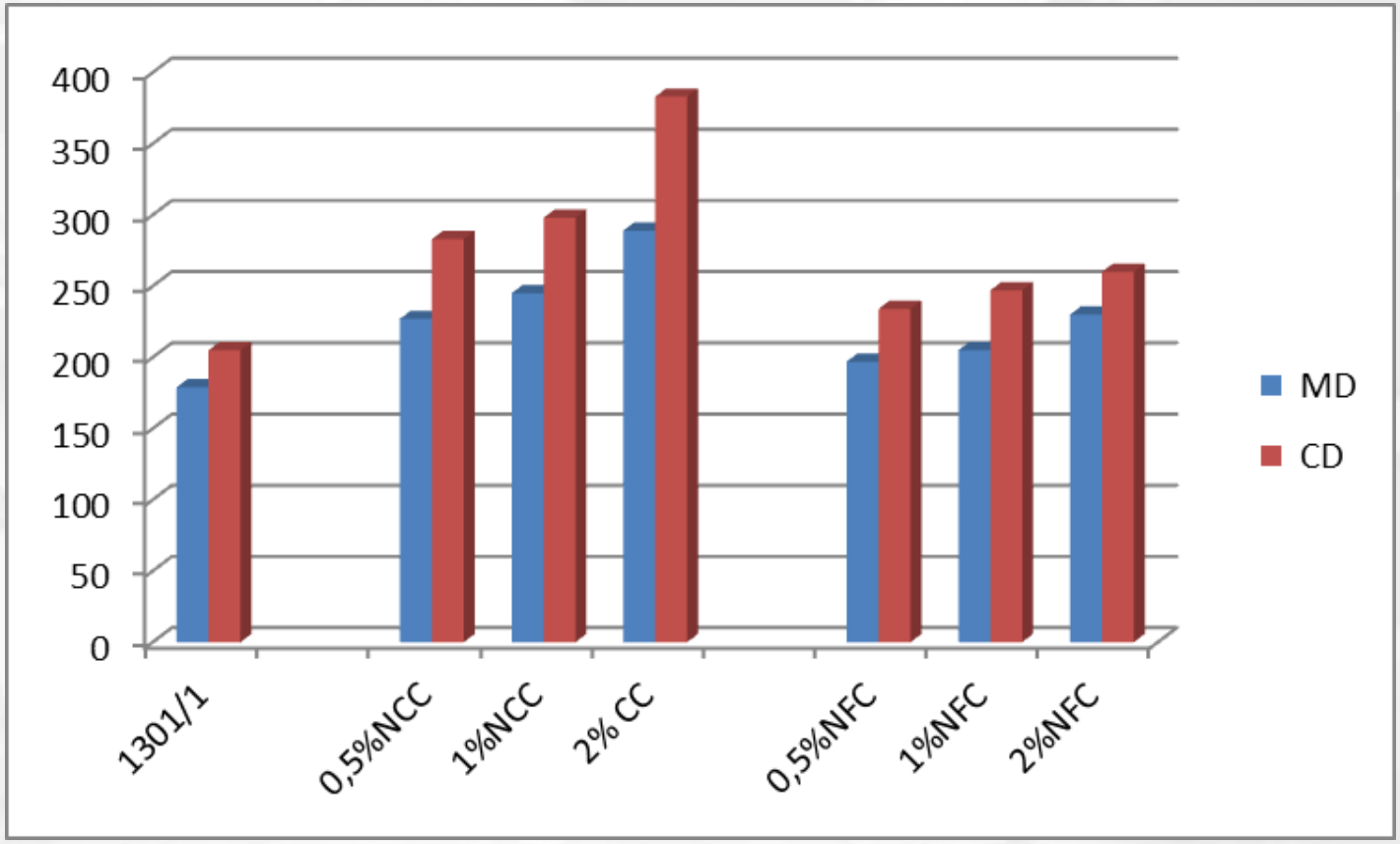
- Single sheet coating of the basic paper with grammage 52 g/m²
- Lab-scale rod coater
- Adhesive coating was performed with rod no. 4
- Paper sheet was put on the coated adhesive surface
- The use of the same pressure was achieved by rod no. 0
- Samples were dried at 60 °C for 2 minutes

IBT - INTERNAL BOND TEST (ISO 16260)

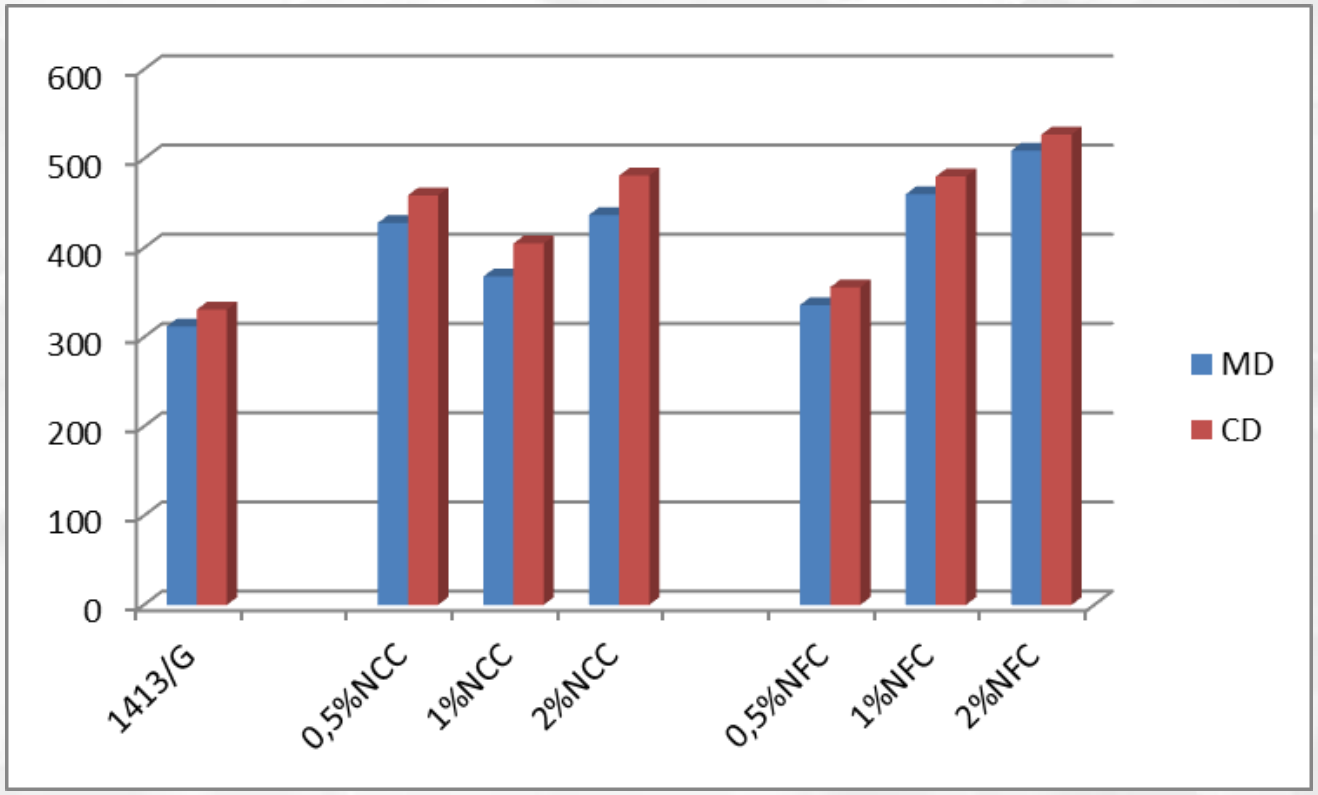


Basic principle

AVERAGE IBT [J/m²] OF ADHESIVE MEKOL 1301/1



AVERAGE IBT [J/m²] OF ADHESIVE MEKOL 1413/G



INCREASE OF IBT VALUES IN %

MEKOL 1301/1

Addition	Increase in % MD	Increase in % CD
0,5%NCC	27	38
1%NCC	37	45
2% NCC	61	87
0,5%NFC	10	14
1%NFC	15	20
2%NFC	28	27

MEKOL 1413/G

Addition	Increase in % MD	Increase in % CD
0,5%NCC	37	39
1%NCC	18	22
2% NCC	40	45
0,5%NFC	8	8
1%NFC	47	45
2%NFC	63	59

CONCLUSIONS

- NFC and NCC nanocellulose were succesfully incorporated to PVAc adhesive and applied to paper
- NCC strongly increases viscosity of PVAc adhesive, while NFC reduces its viscosity
- Addition of NCC increased IBT values from 40-87 %, while NFC from 27-63%
- According to obtained results, nanocellulose can be used to improve adhesive properties of PVAc adhesives

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