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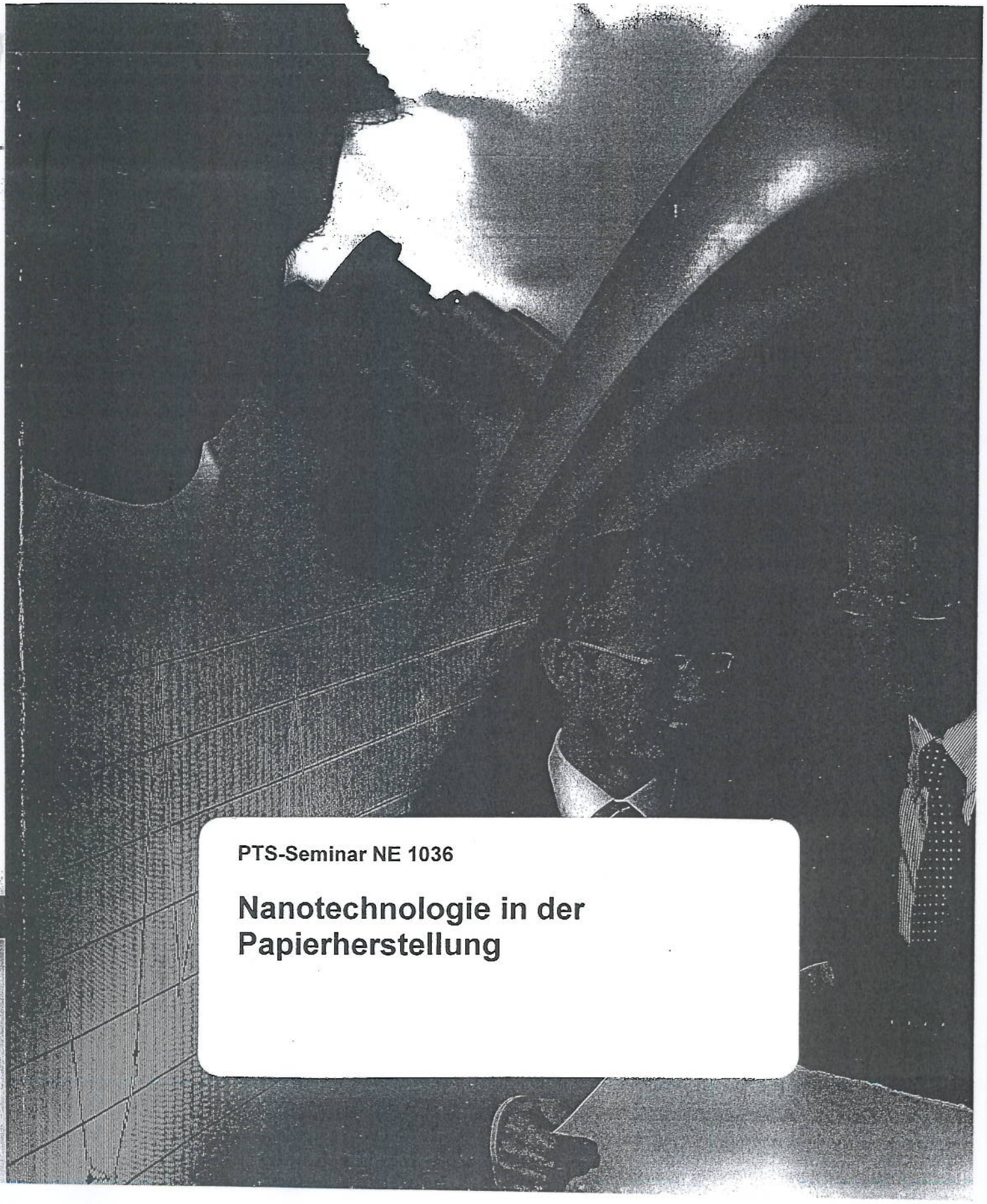

PTS-Seminar NE 1036

Nanotechnologie in der Papierherstellung

NE 1036
13.04. –14.04.2010

Nanotechnologie bei der Papierherstellung

Papiertechnische Stiftung
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Dr.-Ing. Reinhard Sangl
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- ist seit 1991 bei der PTS
- arbeitet auf dem Gebiet der Oberflächenveredelung und ist verantwortlich für Forschungsprojekte und Weiterbildungsveranstaltungen zu dieser Thematik.

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INHALT

Angewandte Nanotechnologie bei der Papierherstellung

Beispiele für angewandte Nanotechnologie

13 Organic nanoparticle barrier coatings with incorporated vegetable oils

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Information about the speakers

The Polymer Technology research Group at the Department of Textiles of Ghent University, lead by prof. G. Schoukens, focusses on the development and characterisation of functional coatings for packaging applications. Pieter Samyn graduated in 2001 as Master in Materials Science and Engineering at Ghent University and received his Ph.D. in 2007 on polymer tribology. After performing several research projects in the field of polymer adhesion and polymer surface science, he took up a post-doc position that is funded by the Research Foundation Flanders.

Topchim N.V./S.A. is an established R&D-driven company that is specialized in the formulation and production of paper coatings and coating additives, based in Belgium and Brazil. President-Director R&D Henk van den Abbeele, directed the recent research efforts of Topchim towards industrial-scale production of nano-hybrid pigments and nano-dispersed biopolymers for paper technology.

Summary

The design of ecological and repulpable barrier layers for paper and cardboard has become an important issue in replacing traditional wax-based and laminated products. The hydrophobicity and water barrier resistance of paper surfaces can be controlled by the adsorption of hybrid organic nano-particles onto the cellulosic substrates. The nanoparticles were synthesized by partial imidisation of poly(styrene-maleic) anhydride in presence of various bio-renewable oils, such as palm-, soy-, corn-, rapeseed- or castor-oil. The reaction parameters were optimized in order to get a stable aqueous dispersion of core-shell nanoparticles with a diameter of 30 to 50 nm, with a maximum amount of 70 wt-% encapsulated oil, and solid content of maximum 65 wt.-%. Chemical interactions between the oil and the organic phase have been studied by Raman and FTIR spectroscopy, and are located at the carbonyl functionalities of styrene-maleic anhydride moieties and fatty acids.

The morphology of papers coated with hybrid organic nanoparticles is more homogeneous than in case pure organic nanoparticles were used, resulting in very low Cobb-values and high hydrophobicity. Also dynamic contact angle measurements confirm that the coatings present a high receding contact angle that is favourable for the development of self-cleaning surfaces. With further thermal heat treatment of the nanoparticle coatings, the oil remained encapsulated into the nanoparticle structure below the glass transition temperature of the organic nanoparticles (but heated above the transition temperature of the oil) and the morphology of the nanostructured coating remained stable, while the oil was released when heating above the glass transition temperature of the organic nanoparticle (180°C). The presented hybrid nanoparticles offer potential to be used in new applications for storage of oil-soluble productus (e.g. dyes, pigments, etc.) and controlled release upon thermal stimuli at the paper surface.

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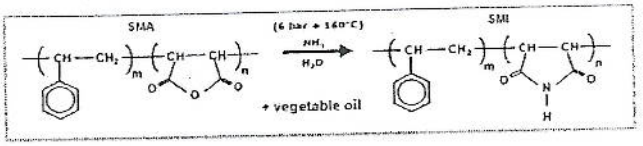
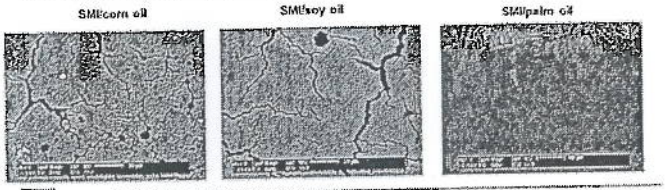
The synthesis of hybrid nanoparticles is done by imidisation of high-molecular weight poly(styrene-maleic anhydride) in presence of bio-renewable oils.



The coating morphology on paper depends on the charactieristics of the encapsulated oil

SMIcorn oil | SMIsoy oil | SMIpalm oil



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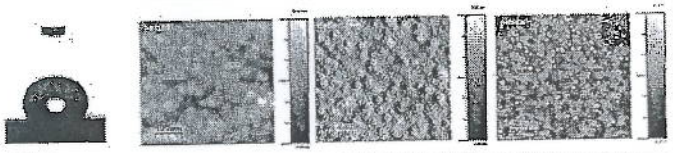
Control of the water-repellence and surface hydrophobicity by increasing palm oil (PO) content in hybrid organic styrene maleimide (SMI) nanoparticles between 40 wt.-% and 70 wt.-%

	Aqueous dispersion characteristics			Coating characteristics			
	pH	S.C. (%)	Nanoparticle size (nm)	Coating weight (g/m²)	Cobb (g/m²)	Particle size (nm)	Contact angle θ_{dyn} (°)
SMIPO-40 wt.-%	7.2	50.8	100 – 120	7	27	25	76
SMIPO-50 wt.-%	8.5	50.0	140 – 160	7	18	30	94
SMIPO-60 wt.-%	7.2	50.6	150 – 200	7	14	50	98
SMIPO-70 wt.-%	7.2	51.8	180 – 230	7	6	80	125

Atomic force microscopy of hybrid nanoparticle coated papers retaining oil



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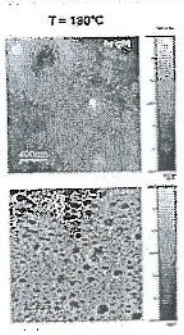
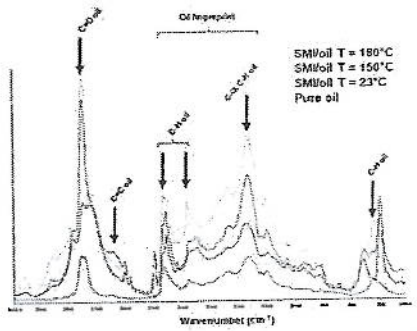
Oil release mechanisms during thermal heating are demonstrated by FTIR-spectroscopy by a progressive increase in coupled oil-related absorption band intensities relatively to the styrene and imide related bands. Atomic force microscopy shows free oil at the coated paper surface.

T = 180°C





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