**OPTIONAL QUIZ QUESTIONS for Course 11: “Nanocellulose Appl. Papermaking”**

Session 1: Introduction: Nanocellulose types & applications

1A – What are the smallest kind of nanocellulose particles?

* Bacterial cellulose (BC)
* Nanofibrillated cellulose (NFC)
* Microcrystalline cellulose (MCC)
* Cellulose nanocrystals (CNC)

1B – Treatment of cellulose with what gives rise to nanocellulose crystal particles having a negative surface charge?

* Hydrochloric acid
* Sulfuric acid
* Cellulase
* Sodium hydroxide

1C – Which type of cellulose product typically is branched with a wide range of thicknesses of the fibrils?

* Cellulose nanocrystals (CNC)
* Microcrystalline cellulose (MCC)
* Kraft pulp fibers
* Nanofibrillated cellulose (NFC)

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Session 2: Characterization methods

2A – The balance between what two components of force can determine the spacing between cellulose nanocrystal particles in a liquid crystal arrangement?

* Electrostatic and thermal
* Electrostatic and van der Waals
* Electrostatic and gravitational
* Inertial and gravitational

2B – Which of the following does NOT help nanocellulose to become fully redispersible in nano form after it has been dried?

* Very low pH
* Sodium chloride addition
* Carboxymethyl cellulose (CMC)
* Intense hydrodynamic shear

2C – Why are particles present in plastic regarded as unfavorable for recycling?

* The properties of the plastic material will differ from what is expected.
* The particles will make the plastic material weaker and more flexible.
* The cellulose-based particles will increase the fire hazard.
* The cellulose-based particle will dissolve during the compounding step.

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Session 3: Wet end addition of nanocellulose

3A – Why does mechanical refining allow kraft fibers to become ribbon-like in the wet state?

* External fibrillation of the fiber walls
* Shortening of the fibers (fragmentation)
* Stretching of the fibers (lengthening)
* Internal delamination of the fiber walls

3B – What is the likely reason why just adding nanofibrillated cellulose to a slurry of untreated cellulosic fibers usually does little to contribute to strength?

* It becomes rapidly agglomerated with itself and then no longer is in extended conformation.
* It hurts the uniformity of the resulting paper.
* Little of it is retained on the fibers in the absence of a cationic polymer.
* It is weak, thus creasing weak boundary layers throughout the material.

3C – Which order of addition is likely to give the most rapid dewatering of paper?

* Nanofibrillated cellulose/cationic starch/fibers/cPAM/SiO2
* Nanofibrillated cellulose/cationic starch/SiO2/fibers/cPAM
* Fibers/cationic starch/cPAM/SiO2/nanofibrillated cellulose
* Fibers/SiO2/cationic starch/cPAM/nanofibrillated cellulose

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Session 4: Rheology of nanocellulose suspensions

4A – What modification is often made to rheology testing equipment when the goal is to evaluate suspensions of nanocellulose?

* Tiny versions of the standard equipment
* Baffles or roughening of surfaces
* Anti-deposition (release) coating of the surfaces
* Polishing to minimize clinging of the nanocellulose

4B – What explains the huge range of viscosity results for different studies evaluating the rheology of CNC suspensions under the same nominal conditions?

* The particle aspect ratio diverges by huge amounts from one study to another.
* Different studies employ different kinds of test equipment.
* In some studies the shear rate is increasing, whereas in other studies the shear rate is decreasing during an individual test.
* Sometimes the particles are able to form a contiguous structure that fills the volume and sometimes not.

4C – Which of the following additives would be expected to act as a dispersant for nanocellulose?

* Sodium polyacrylate
* Cationic starch
* Colloidal silica
* Aluminum sulfate

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Session 5: Nanocellulose at size press and coatings

5A – According to the Kozeny-Carman equation, an increase of what factor can be expected to increase resistance to the flow of air of other fluid through paper, with or without the presence of nanocellulose?

* Increasing particle size
* Floating of the cellulosic material
* Gravitational settling of the solids
* Increasing specific surface area

5B – What property usually falls with increasing content of nanocellulose in a dried starch film?

* Tensile modulus
* Bending modulus
* Modulus of rupture
* Elongation to breakage

5C – Why does optical transparency usually fall with increasing addition of nanocellulose?

* Greater light absorbance
* Greater light scattering
* Greater light specular reflection
* Greater light polarization

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Session 6: Barrier layers with nanocellulose

6A – Which film-forming method involves the evaporation of liquid?

* Extruding
* Drainage
* Casting
* Plasma (corona discharge)

6B – Which of the following can explain the high ability of a dry nanofibrillated cellulose film to resist the transport of oxygen?

* Hydrophobic character
* High cohesive energy density
* Ability to bind oxygen molecules
* High component of London dispersion interactions

6C – Why do cellulosic materials usually have low efficiency of tortuosity effects?

* Very low crystallinity of ordinary cellulose
* Fibrillar shape of the structural parts
* Film density is too high, favoring solubility of the oxygen
* Oxygen’s ability to penetrate through cellulose crystals

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Session 7: Nanocellulose surface modification

7A – What functional group on the cellulose surface is most commonly reacted with as a means of chemically modifying the surface?

* -OH
* -COOH
* xylan
* aromatic ring

7B – What type of reagent commonly is used in a treatment resulting in a 3-dimensional (not monolayer) molecular film at a cellulosic surface?

* Isocyanates (to form a polyurethane film)
* Alkenylsuccinic anhydride (ASA)
* Alkylketene dimer (AKD)
* Trialkoxysilanes with tetraethoxysilane

7C – What kind of surface derivatization can be catalyzed by a lipase enzyme?

* Silanization
* Esterification
* Amidation
* Ether formation

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Session 8: Composites and nanocellulose

8A – What factor is usually most important to achieve higher tensile breaking strength when adding particles to a plastic matrix?

* Particle size
* Effect on matrix crystallinity
* High dimensional stability of the cellulose
* Interfacial compatibility

8B – Which of the following polymer matrix types is most compatible with typical cellulosic particles?

* Polyethylene
* Polypropylene
* Poly(lactic acid)
* Starch

8C – Why can a wax layer increase the oxygen barrier performance of a nanofibrillated cellulose layer in a film?

* It acts as a plasticizer, so that the cellulose is less likely to break.
* It prevents crystallization of the film.
* It resists the adsorption of oxygen molecules at the surface.
* It resists wetting of the film and plugs cracks or pinholes.

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