**Course 11, “Nanocellulose Applications in Papermaking,” Final Quiz**

**Complete the following form and take the quiz to receive a certificate of course completion. Please enter your information in the way you would like it to appear on your certificate. Send your completed form (in WORD or PDF format) as an email attachment to hubbe@ncsu.edu.**

**Your full name (print carefully or type):**

**Your affiliation (school, company, etc.):**

**Your email address:**

**Having taken this course will help me to…**

**This course could be improved by…**

**My idea for a future course in this series would be…**

FINAL QUIZ FOR COURSE 11 (ten questions)

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

1. Hydrochloric acid
2. Sulfuric acid
3. Cellulase
4. Sodium hydroxide

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

1. Electrostatic and thermal
2. Electrostatic and van der Waals
3. Electrostatic and gravitational
4. Inertial and gravitational

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

1. External fibrillation of the fiber walls
2. Shortening of the fibers (fragmentation)
3. Stretching of the fibers (lengthening)
4. Internal delamination of the fiber walls

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

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

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

1. Tiny versions of the standard equipment
2. Baffles or roughening of surfaces
3. Anti-deposition (release) coating of the surfaces
4. Polishing to minimize clinging of the nanocellulose

6 – 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?

1. Increasing particle size
2. Floating of the cellulosic material
3. Gravitational settling of the solids
4. Increasing specific surface area

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

1. Tensile modulus
2. Bending modulus
3. Modulus of rupture
4. Elongation to breakage

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

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

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

1. -OH
2. -COOH
3. xylan
4. aromatic ring

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

1. Polyethylene
2. Polypropylene
3. Poly(lactic acid)
4. Starch