**WWSC Academy, Summer School 2021**

**Virtual Edition**

**Biocomposites; Relationship between Processing, Structure and Properties**

**Scientific leaders: Prof. K. Oksman and Prof. L. Berglund**

**3.0 ECTS credits**

**September 6 - September 10, 2021**

**Knowledge objectives**

Know the raw materials used in biocomposites

Basics concepts for fiber composites

Basic concepts for natural fiber biocomposites and nanocomposites

Basics of composite micromechanics (mechanical properties). Important parameters for biocomposites microstructural characterization, mechanical testing, data reduction, analysis of results.

Principles of processing using thermoset and thermoplastic polymers. Vacuum assisted resin impregnation, compounding of biocomposites, compression molding, injection molding.

Processing of industrial composite products.

Interface, interphase, moisture effects.

Biocomposite properties and product design.

Cellulose nanomaterials and processing: orientation of latest research developments and scientific challenges and applications

**Implementation:**

The course materials are in Canvas room and lectures Lecture notes, group exercises, virtual lab demonstrations, virtual study visits at Tetrapack, RISE SICOMP, ABB, Podcomp, Stora Enso will be available in this room.

**Concepts:**

* Introduction, history of wood polymer composites (Kristiina)
* Raw material constituents (plant fibers, wood fibers, polymers) (Kristiina)
* Basics on fiber composites, natural fiber composites and nanocomposites (Lars)
* Mechanical properties, micromechanics, orientation, fiber length (Roberts)
* Interface, interphase and moisture sorption (Lars)
* Processing methods; thermosets, thermoplastics composites (Kristiina)
* Important properties (Kristiina)
* Designing biocomposite products (Ignaas Verpoest)
* Cellulose nanofibers and their separation processes (Linn)
* Nanocellulose composites, hybrids and processing (Shiyu)
* Nanocomposites applications (H. Yano?)

**Monday**

**Morning session 9-12**

1. Introduction, history lecture of WPC. K Oksman
2. Material constituents, fibers, polymer matrices. K Oksman
3. Basics of fiber composites. Lars Berglund

**Afternoon session 13-17**

**Study visit at Tetrapak 13-15**

**1st Group work: Biocomposites tomorrow**

**Tuesday**

**Morning session 9-12**

1. Mechanical properties. Roberts Joffe
2. Micromechanics, orientation, fiber length. Roberts Joffe
3. Interface and interphase, fiber surface treatments and moisture. Lars Berglund

**Afternoon session 13-16 Virtual study visits**

**RISE Sicomp, ABB Composites and Podcomp**

**Afternoon 16-17 Groupwork: Presentations of the 1st Group work**

**Wednesday**

**Morning session 9-12**

1. Biocomposites processing with thermoset polymers and thermoplastics. K Oksman (+ extrusion lecture D Schwendemann)
2. Biocomposite properties. K Oksman
3. Biocomposite products design. Ignaas Verpoest (guest lecture)

**Afternoon session 13-17**

**Study visit Stora Enso**

**2nd group work? Use of natural fibers instead of glass.**

**Presentation of 2nd Group work**

**Thursday**

**Morning session 9-12**

**LTU virtual Lab exercises:** Thermoplastic compounding, dosing, weight fraction-volume fraction of wood polymer composites, injection molding (K Oksman. L Völtz)

Biocomposite property testing. How the addition of wood fibers is affecting mechanical properties, microstructure, density, melt flow. S Geng, L Berglund)

Vacuum infusion of fiber composites and their testing (Oksman & Zainab).

**Afternoon session 13-17**

**3rd Group work with lab data, report writing/oral presentation of the results.**

**Friday**

**Morning session 9-12** (Discussion or questions of the laboratory, report etc.)

1. Cellulose nanofibrils and their processing. Linn Berglund
2. Perspectives on cellulose nanocomposites, nanopaper, predicting properties of CNF composites, thermoplastic CNC and CNF composites. Dispersion and compatibility, processing challenges. Shiyu Geng
3. Cellulose nanocomposite applications. Hiroyuki Yano, Kyoto University, Japan

**Afternoon session 13-16**

**4rd Group work: New functional nanocellulose composites**

**Presentation of the group work**