Prof. of Practice Juha Lipponen

2 Postdocs
3 Master's students

Research Field

Modification of cellulose barrier, hydrophobicity and optical properties, intumescent and flame retardancy of cellulose and lignin, study on properties of wood based mechanical composites Possible products and materials

Applications

Cellulose biobarriers, Cellulose replacing TiO_2, Fire Retardant materials, AaltoCell from wastepaper, Mechanical cellulose composites (e.g. with 3D-printing)

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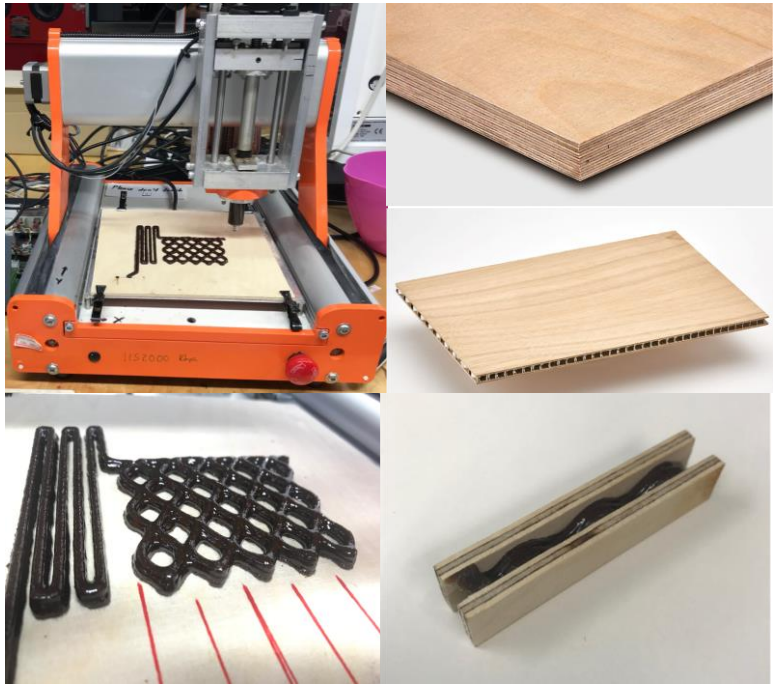
AMBIO

Developing sandwich structures with novel biobased composite using additive manufacturing

What?

Utilizing the 3D-printing method to manufacture the sandwich panel by using thermoset-based polymer as ink and plywood as face sheets

How?



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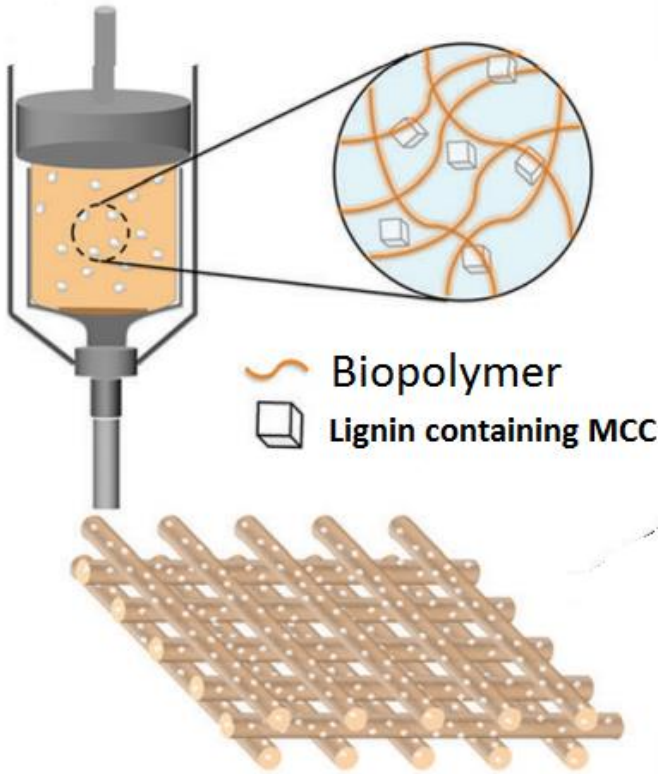
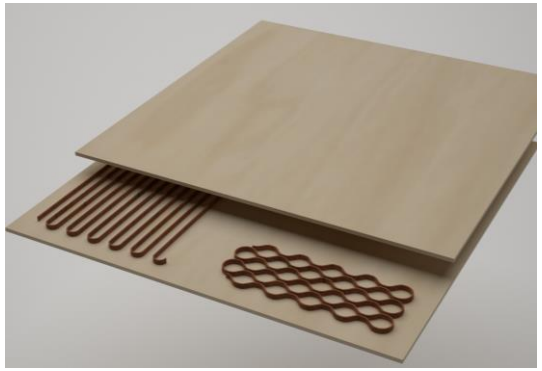
(Potential) Applications

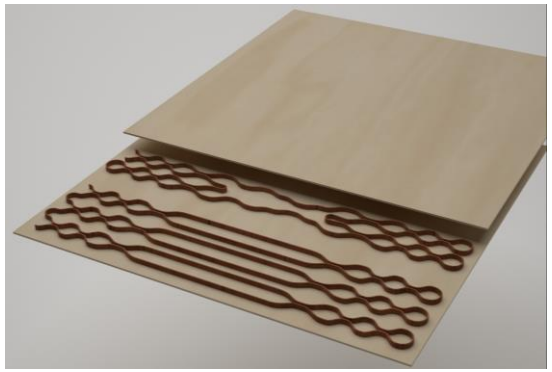
To improve the mechanical properties of conventional plywood

E.g., Furniture industry like chair and table

Current Highlight







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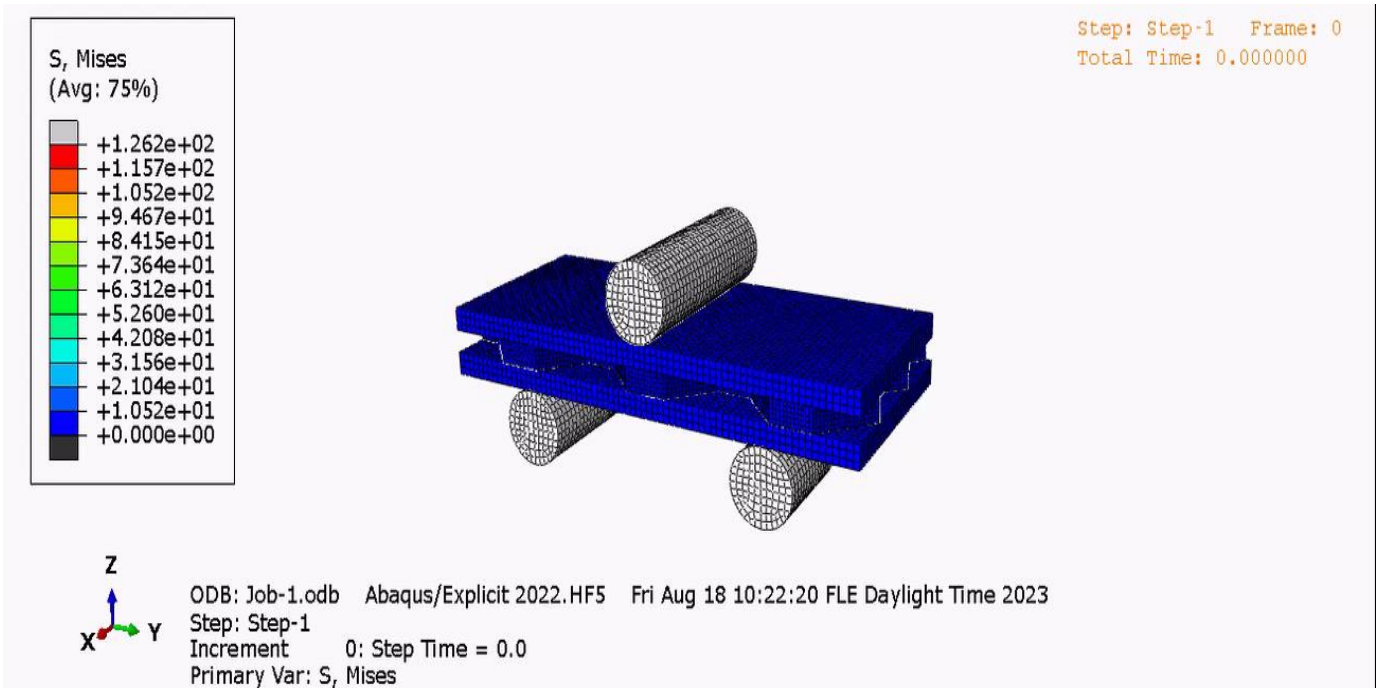
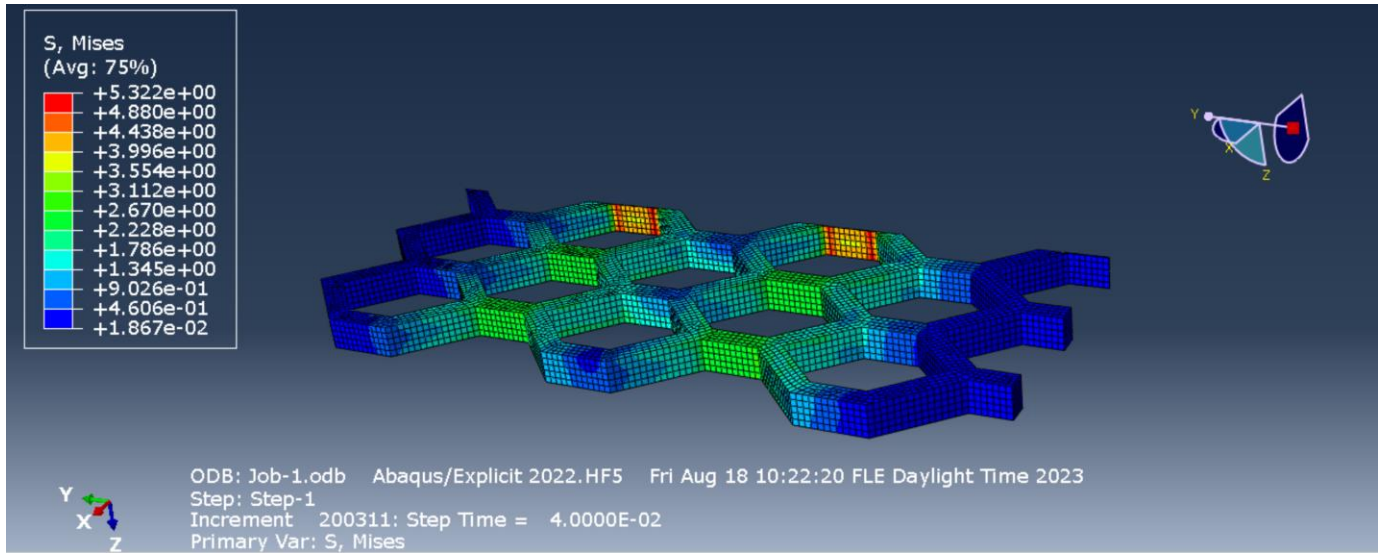
finite element method (FEM)





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BIOSUOJA

Research to develop bio-based fire retardant

What?

Formulation of bio-based hybrid materials that will demonstrate superior fire retardancy.

How?

- Coating or impregnation of wood with bio-based fire-retardant.
- Chemical modification of bio-materials such as cellulose, lignin and other bio-polymer for fire retardance.
- The combination of chemically modified bio-based fire retardants with additional fire-retardant additives to enhance overall fire retardance.
- The incorporation of biobased fire retardants and fire-retardant additives into commercial paint formulations.

Target materials	Biobased fire retardants	Chemical modification	Fire retardant additives
Wood Textile	Chitosan Lignin Phytic acid Tannic acid Sodium alginate Sodium phytate Alginic acid Polyethylenimine (PEI)	Phosphorylation Amination alkylation	Carbone nanotube Fe_3O_4 K_2CO_3 Zn^{2+}, Mg^{2+}, Ba^{2+}, Ni^{2+}, MOF Montmorillonite (OMTT) Ammonium polyphosphate (APP)

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Possible Applications

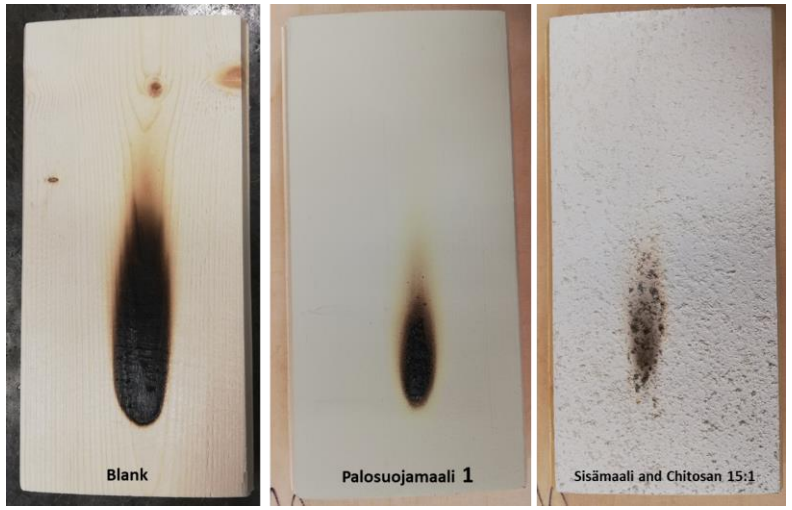
To enhance the fire protection of materials E.g., wood and textile

Test Procedure

- Paint formulation
- Sanding and dust removal from samples
- Coating of the samples
- Measurement of the coating amount
- Vertical burning test
- Selection of the best paint formulation
- Cone calorimetry test

Vertical burning test setup

Vertical burning test Video



Test result

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Optimization of test procedure, materials and method will develop continuously.

Lignin as a carbon source for intumescent flame retardants (IFR)

Working principle of IFRs:

- when exposed to heat, the coating forms an expanded insulative char layer

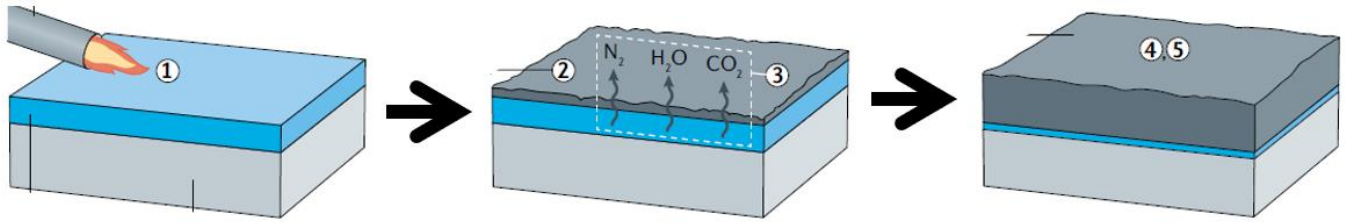
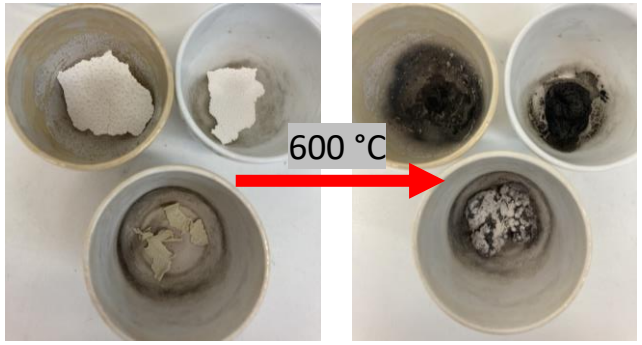


Figure: Lazar et al. Nat Rev Mater 5, 259–275 (2020).

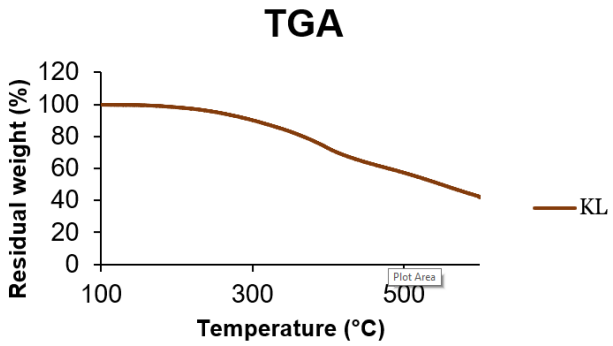
IFR consists of:

- Carbon source -> **Lignin**
- Acid catalyst
- Blowing agent
- Binder



Experimental methods:

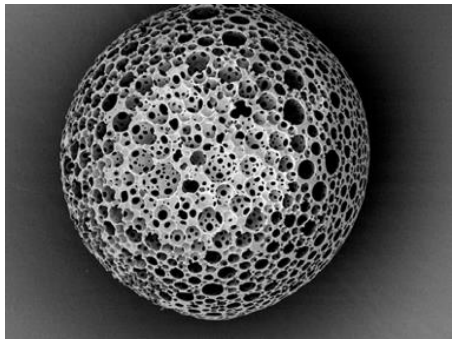
- TGA
- Muffle furnace
- Vertical flame test
- Cone calorimetry



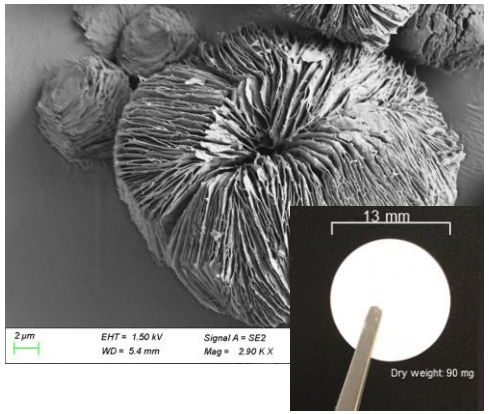
Replacing Titanium dioxide with Cellulose

With a network of cellulosic boundaries / porosity

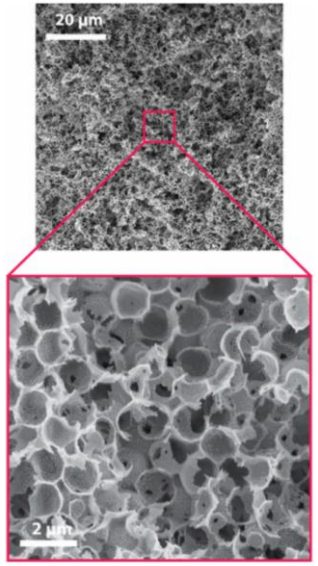
- TiO_2 is a environmentally and health hazardous mineral, that is widely used as a white pigment in paints, cosmetics and plastics
- Here, we aim at replacing TiO_2 with cellulose
- The proposed/upcoming research include
  - Master's Thesis to be started in September



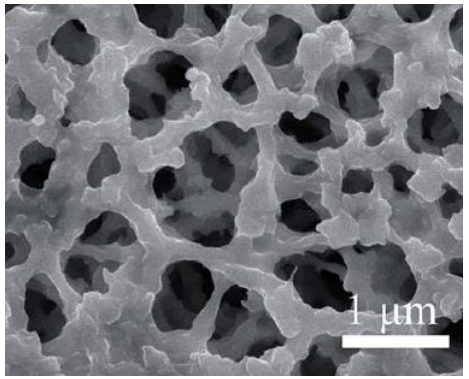
Cellulosic "Swiss cheese" in crystalline cellulose?



Ultra bright white cellulosic material with layered cellulose β(1→3)-glucan synthesis?
(Source: VTT)



Polystyrene beads created void structure in cellulose => increased opacity?



Other ways in creating a LOT of nanoscale air-cellulose boundaries?

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Bio Bubble Wrap and Foam

- Preparing Business to Finland Research to Business application in cooperation with XAMK and FiberX
- 18 months project

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