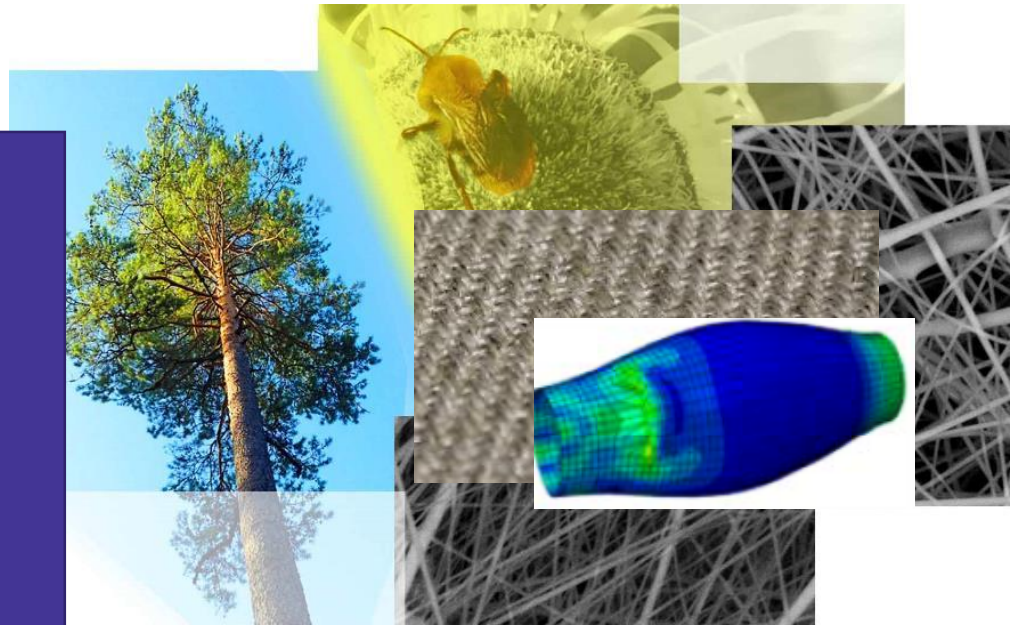


# Destroy and degrade polymers: the roles of simulations and mechanics

Asst. Prof.  
**Mikko Kanerva**



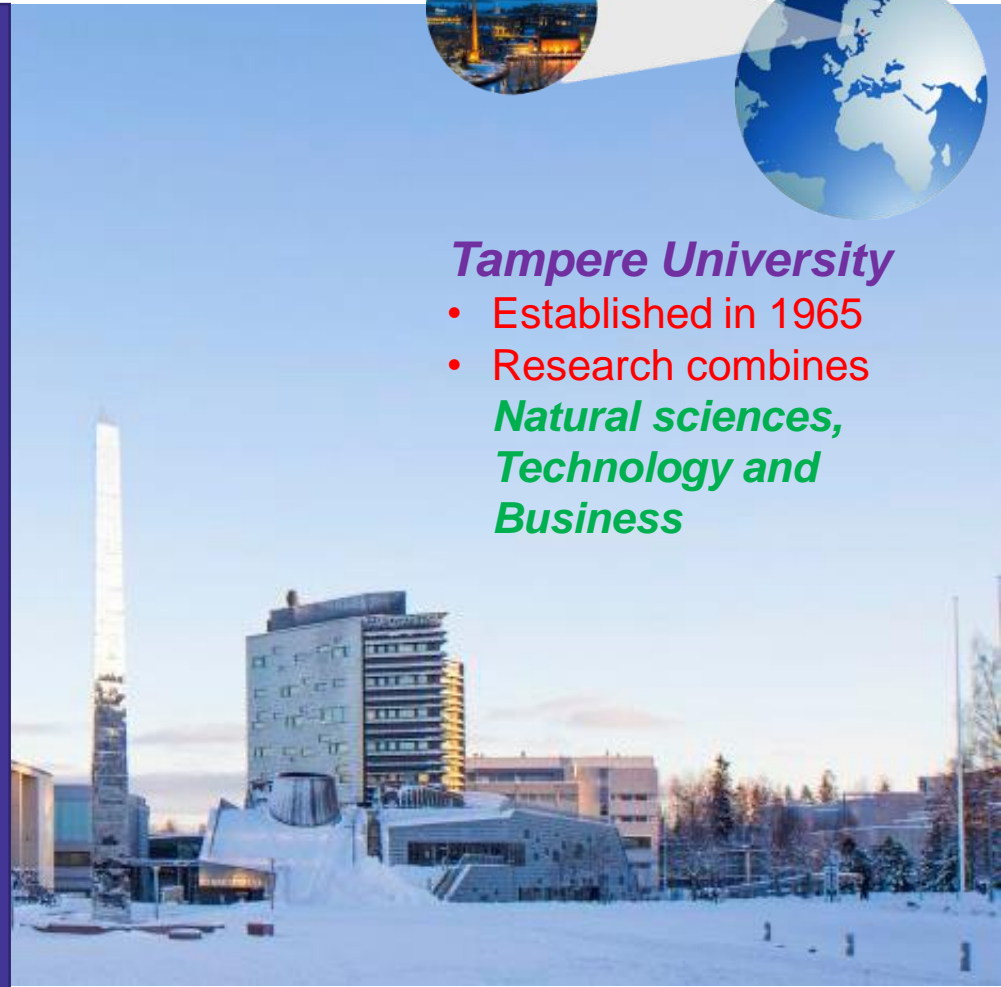
## *Contents:*

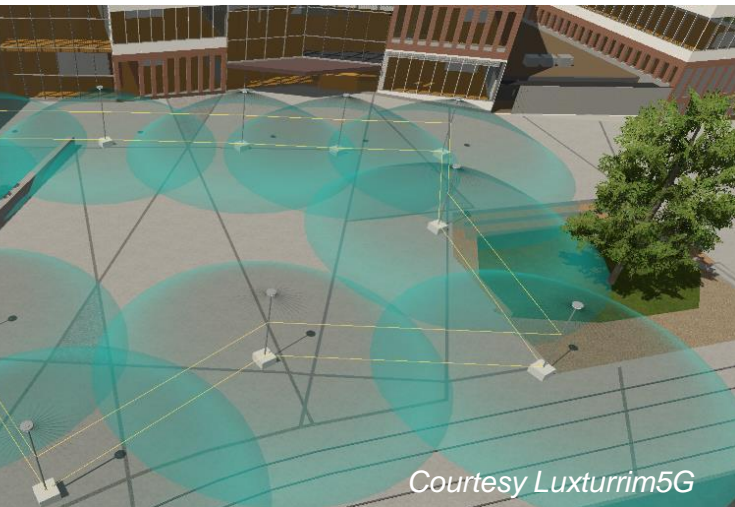
- Global trends
- Research examples
- Future & visions



### ***Tampere University***

- Established in 1965
- Research combines  
***Natural sciences,  
Technology and  
Business***





Courtesy Luxturrim5G



**CO<sub>2</sub>**  
**NS NO<sub>x</sub>**  
**42 140**

# Global trends

Effects of Aircraft Noise:  
Research Update on  
Selected Topics



- **Health effects:**  
To use less **toxic** additives
- **Bio-based materials:**  
...less **emissions** (NOX, CO2)
- **Accumulation in nature:**  
...prevent **(micro-) plastics**
- **Natural materials:**  
...**understand** design and processing



**Discover**  
SCIENCE FOR THE CURIOUS

## Honeybee Survival Is In Jeopardy

The economically important pollinators are dying and saving them is difficult for several reasons.

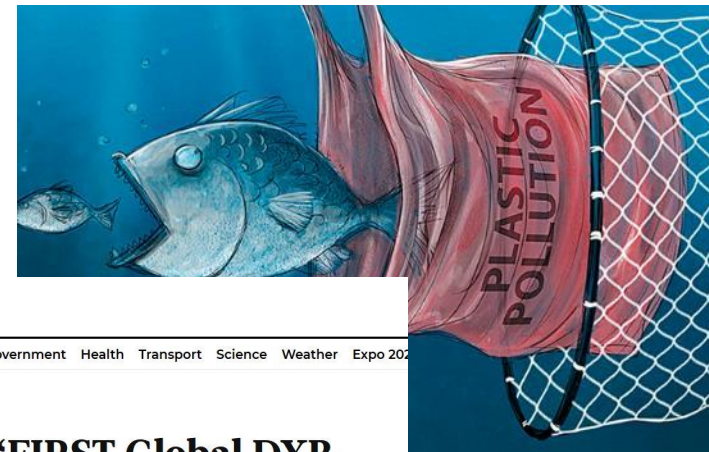
By Steve Volk | Thursday, January 3, 2019

RELATED TAGS: ECOLOGY, SUSTAINABILITY, POLLUTION, ENVIRONMENTAL POLICY

THE ECONOMIC TIMES | Politics and Nation



## India shelves plan on countrywide ban on single-use plastic products



**UAE**

Crime Education Environment Government Health Transport Science Weather Expo 2020

**Dubai to host 'FIRST Global DXB Challenge' from October 24 to 27**

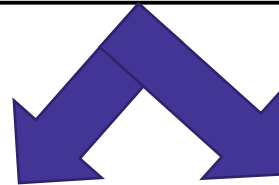
# Solution platform?

- Can products be recycled and does legislation support (by force) various stakeholders?
- How products/material decompose in different environments?
- How long products operate?



# Solution platforms

- How products/material decompose in different environments?
- How long products operate?



- What is the base material?
- What are the additives?
  - Can degradation be controlled?

- Preferred long-term operation
  - **High mechanical durability**
  - **High functional durability**



# Examples of research

# Natural additives

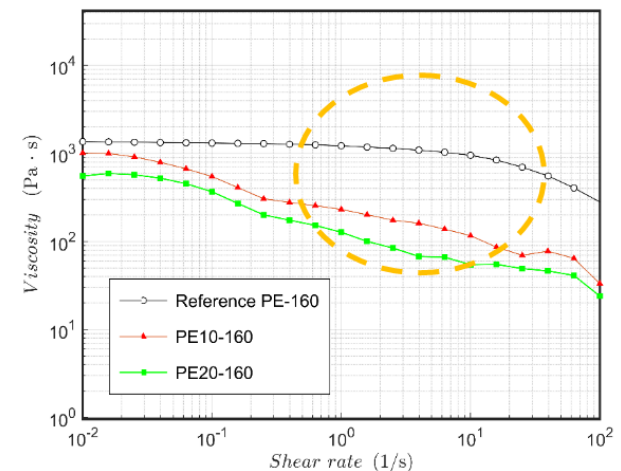
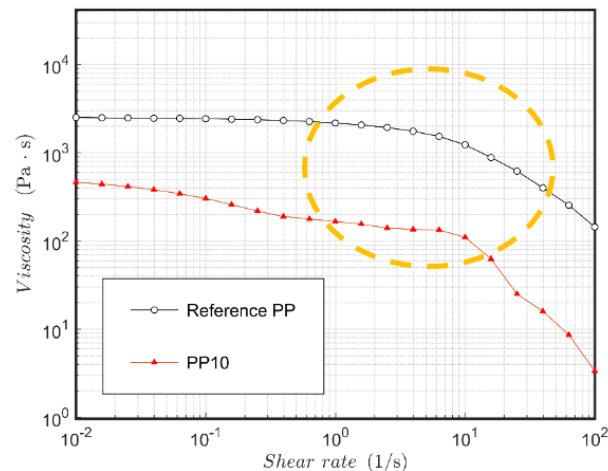
- Pine rosin as natural, antibacterial additive
- Target: Industrial partners wanted to study the effects of rosin on compounding and fibre spinning



1. compounding



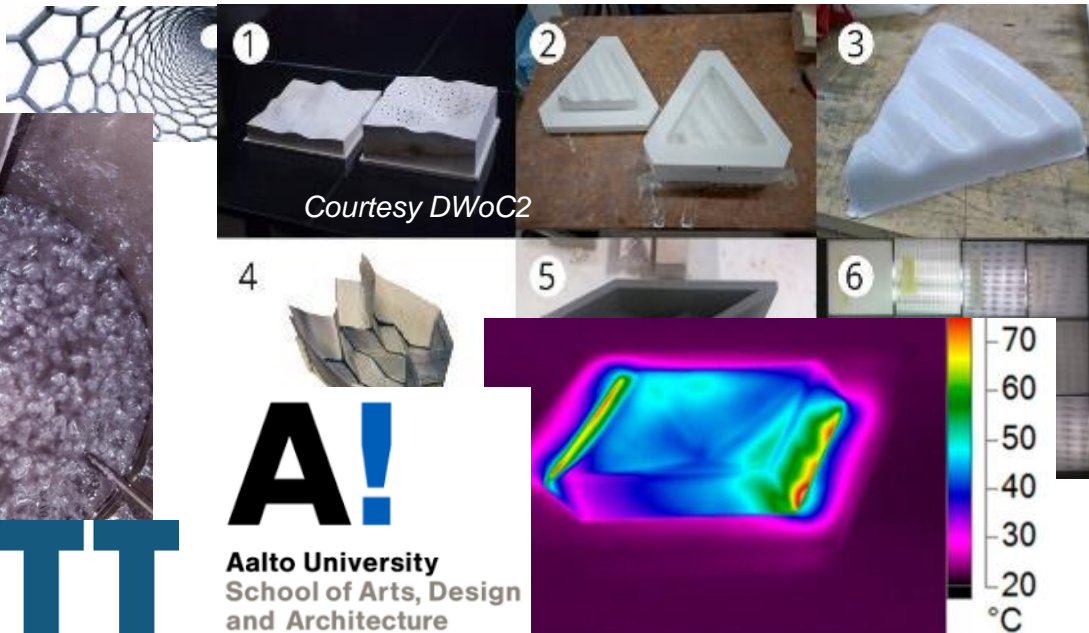
2. analyzing



# Functionality

- Electrical conductivity into cellulose based materials?
- Target: as high as possible technology readiness level to be achieved with (nano-) cellulose based materials

 Synthesis and mechanical durability of conductive films was studied



High conductivity!



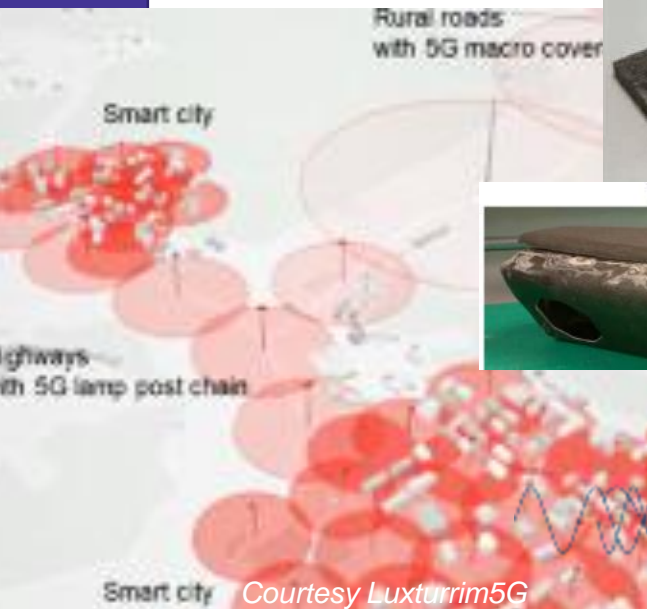
Siljander, S. et al. **Materials**. 2019,  
DOI: 10.3390/ma12030430

# Operation - disposal

- Future cities are larger and denser in population and also denser in terms of products with high-tech functionality
- How is the physical appearance of these products?



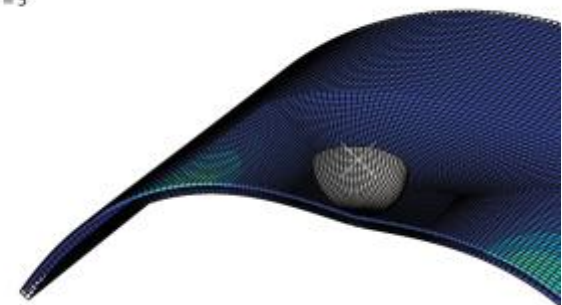
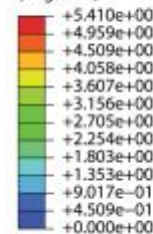
Polymer composites for wireless technologies?



Finishing treatments

Then?

HSNMTCRT  
SPOS, (fraction = 1.0), Layer = 5  
(Avg: 75%)



NOKIA Bell Labs

PREMIUM

LuxTurrim 5G

VTT



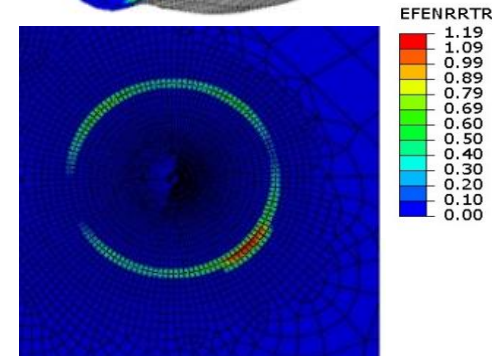
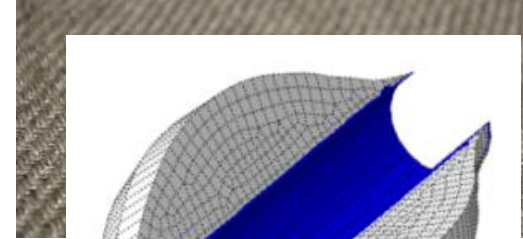
VAISALA

# Mechanical durability

- Natural raw materials typically have limited mechanical performance
- Re-design needed – conceptual and detail design to be re-made
- **For numerical predictions, material data not available and/or no appropriate test methods**

FibreNet

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**Fundamental research of test methods for model validation needed**



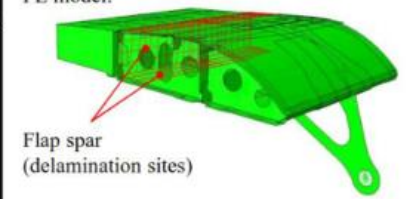
**New damage models needed**

1. J. Jokinen, M. Wallin, O. Saarela,  
Int J Adhes Adhes 62 (2015), 85-91.

2. J. Jokinen, M. Kanerva, M. Wallin, O. Saarela,  
Int J Adhes Adhes , 88 (2019), 50-58.



FE model:



# Future

# Future vision

An increasing amount of non-linear analyses with new:

- ***Material models***
- ***Interface models***
- ***Multi-physics simulations***
- ***Sensitivity analyses***

related to either ever *high-performing* materials  
or *natural* (raw) materials

# Thank you!

- Materials Science
- Collaborators
- Funding agencies

(Business Finland, EU, Finnish Defence Forces, Finnish industry, TAU)

## Questions?

Contact for collaborations and more details:  
**[mikko.kanerva@tuni.fi](mailto:mikko.kanerva@tuni.fi)**