

# Biocomposites and Carbon Nanomaterials Filled Hybrid Composites

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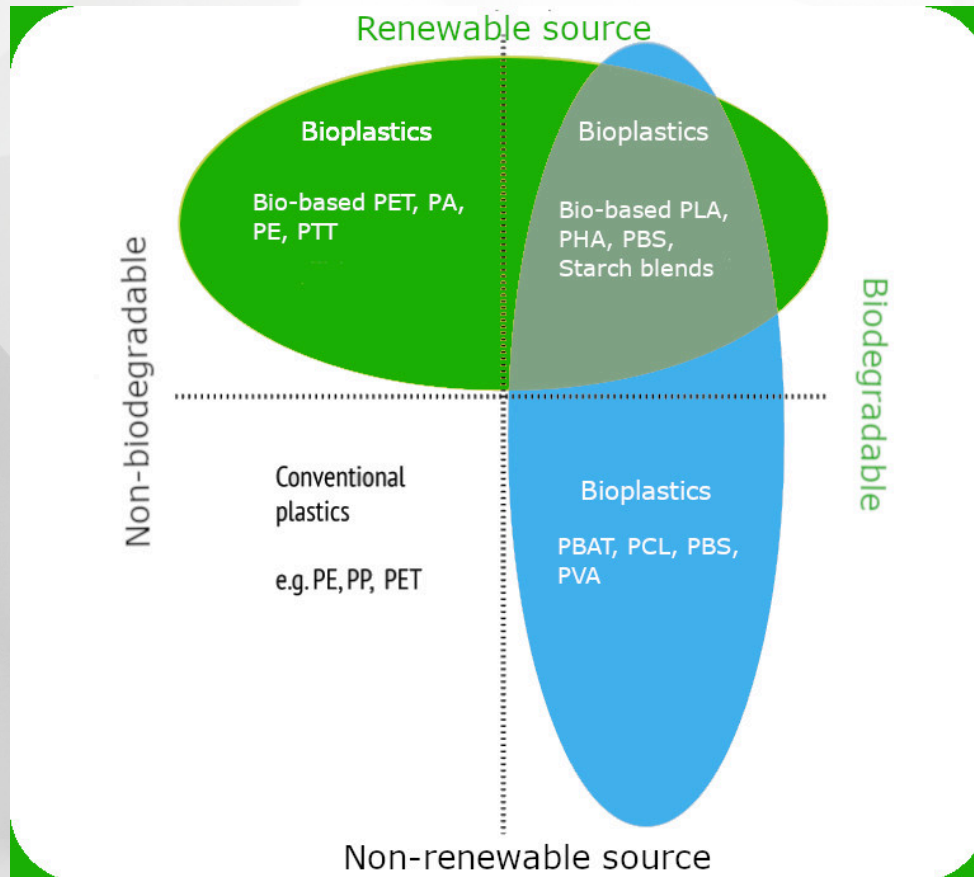
*Recent advances in functionalized plastic materials, bio-based materials and additive manufacturing | 11<sup>th</sup> September 2019 | Centria UAS, Kokkola, Finland*

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# Outline

- ❑ Bioplastics
  - Driving factors and applications
  - Market share - bioplastics
  
- ❑ Biocomposites
  - Driving factors and Applications
  - Market share - biocomposites
  
- ❑ Smart WPC – Electrically conductive wood plastic composites

# Bioplastics



- ☐ Bio-based polymers are those produced from biomass
- ☐ Not all bio-based polymers are biodegradable/compostable
- ☐ Some of the fossil-based polymers are biodegradable/compostable

Source: Adapted from European Bioplastics/Nova Institute

# Bioplastics

## Labels for bio-based plastics

- ❑ Certification of biobased content refers to biobased carbon content. It is based on the European norm EN 16785-1 "Biobased products -Biobased content -Part 1: Determination of the biobased content using the radiocarbon analysis and elemental analysis"



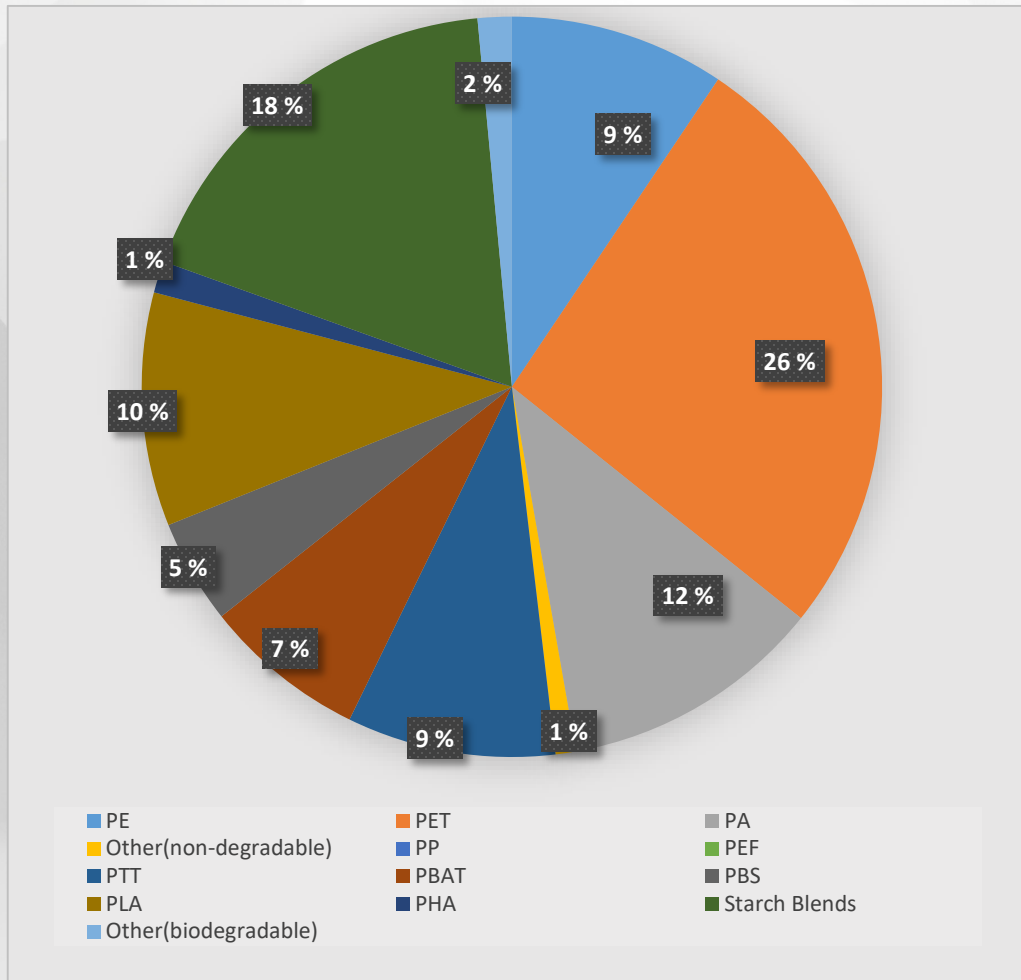
Source:

<https://www.ieabioenergy.com/wp-content/uploads/2018/10/Standards-and-Labels-related-to-Biobased-Products-2016-to-2018.pdf>

[https://docs.european-bioplastics.org/2016/publications/fs/EUBP fs standards.pdf](https://docs.european-bioplastics.org/2016/publications/fs/EUBP_fs_standards.pdf)

# Bioplastics

## Global bioplastic production capacity in 2018



- ❑ Global production capacity was reported as 2.11 million tonnes
- ❑ The expected growth in bio-based durable plastics between 2018-2023 is around 11%
- ❑ An increase of 41% is predicted for biodegradable plastics in the period 2018-2023

# Bioplastics

## Driving Factors

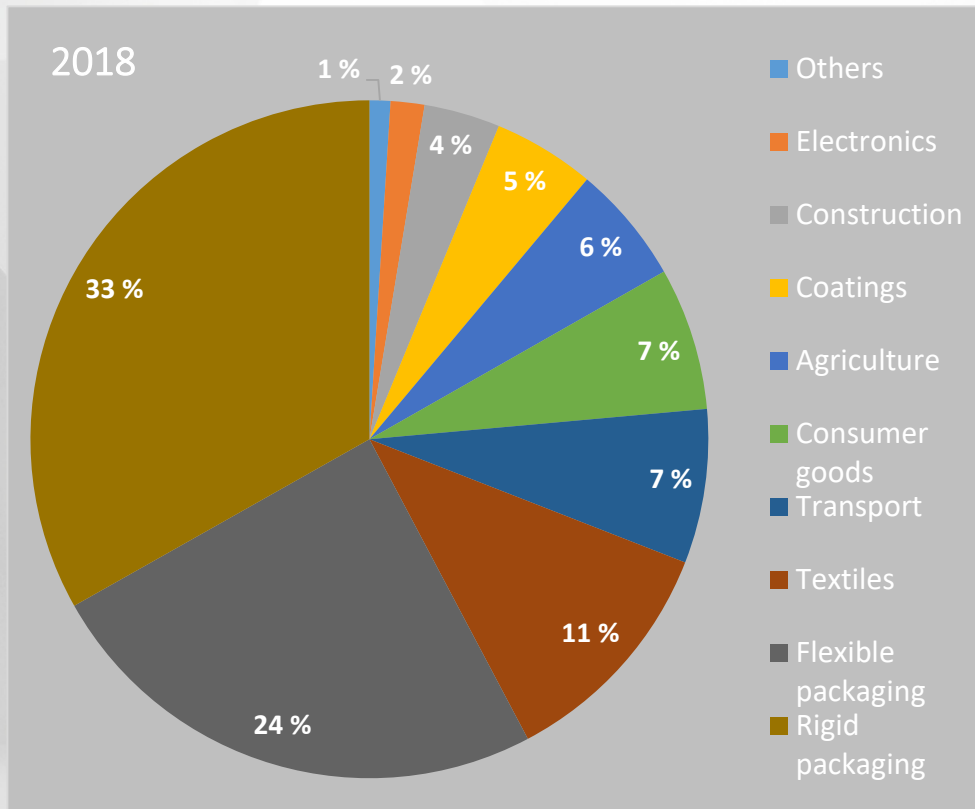
- ☐ Consumers preference for eco-friendly materials
- ☐ Leading chemical and plastic companies who are seeking for sustainable alternatives
- ☐ Regulations that promotes sustainable development and related innovations





# Bioplastics

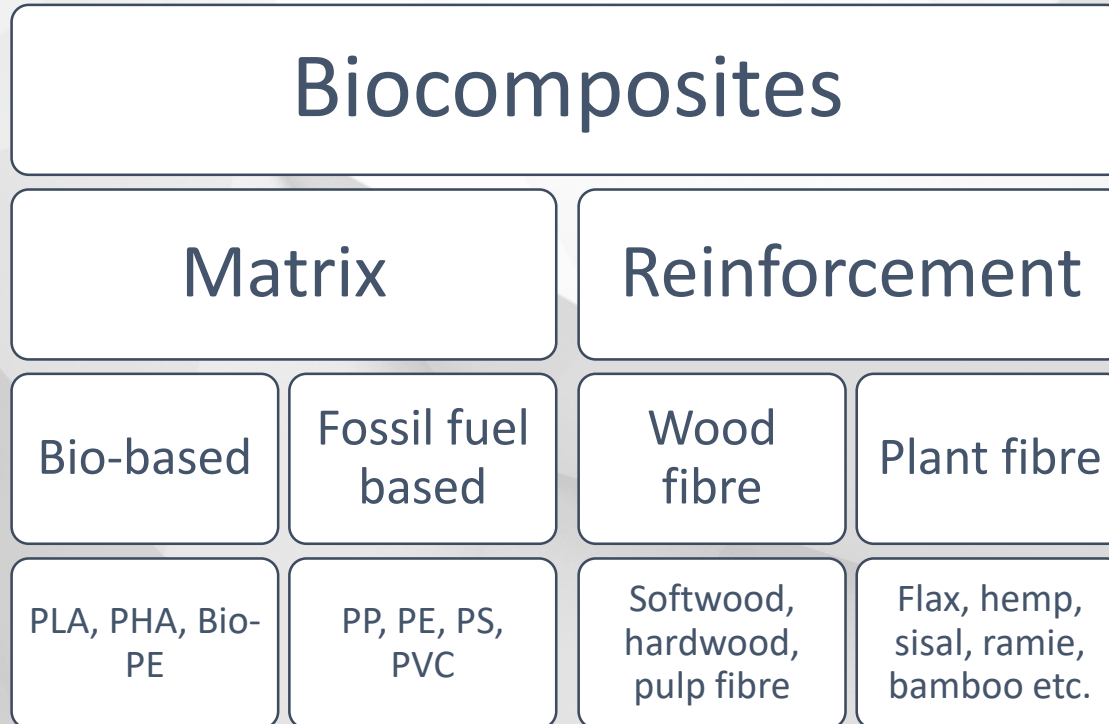
## Applications



Adapted from: European Bioplastics/Nova Institute

- ❑ Packaging is the largest field of application for bioplastics with around 60% of total bioplastic market in 2018
- ❑ It is worth to note that flexible packaging sector is highly dominated by biodegradable plastics
- ❑ Automotive and transport sector is dominated by Bio-PA and Bio-PET

# Biocomposites



- ❑ Biocomposites consist of bio-based plastics or fossil fuel plastic as matrix and wood flour/plant fibre as reinforcing element
- ❑ Common biocomposites can be classified as 'Wood fibre composites' (WPC) and plant fibre reinforced plastic composites (NFRPC)



# Biocomposites

## Main drivers

- ☐ Adding value to waste natural fibres
- ☐ Require less energy to produce and process
- ☐ Utilization of recycled plastics is in line with EU 'Plastic strategy'
- ☐ Sustainable product development
- ☐ Interest from automotive and other market sectors for sustainable and lightweight materials
- ☐ Renewability, Biodegradable, Recyclability

# Biocomposites

## Applications of biocomposites



Source

<https://www.orthexgroup.com/inspiration/bio-based-materials>

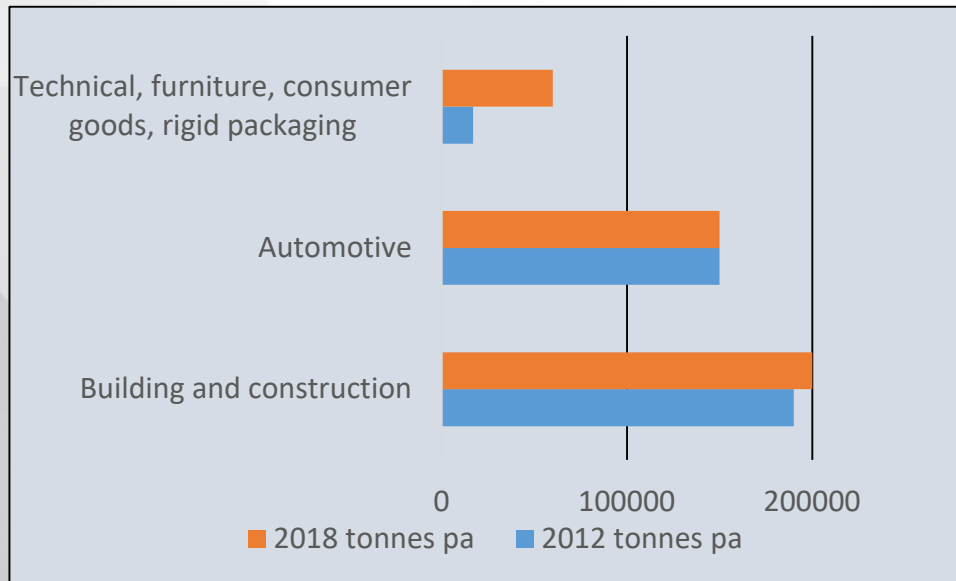
<https://www.trifilon.com/injection-molding-material>

<https://www.aqvacomp.fi/en/applications/>

JEC composites

# Biocomposites

## Market share



Adapted from: Asta Partanen and Michael Carus, Biocomposites are a great alternative. bioplastics MAGAZINE 04/19 Vol 14.

# Smart wood plastic composites

## Project goals

- Smart WPC aims to integrate add-on functionalities in WPC by incorporating thermally and electrically conducting fillers
- Another objective of the project is to develop manufacturing technologies to produce hybrid F-WPC with improved structural properties, continuous cellulose fibre will be utilized as reinforcement for this purpose.
- The project will fill the knowledge and technological gap that prevent the use of commercialized bio-based materials in functional and highly required structural applications in various industrial sectors.

# Processing



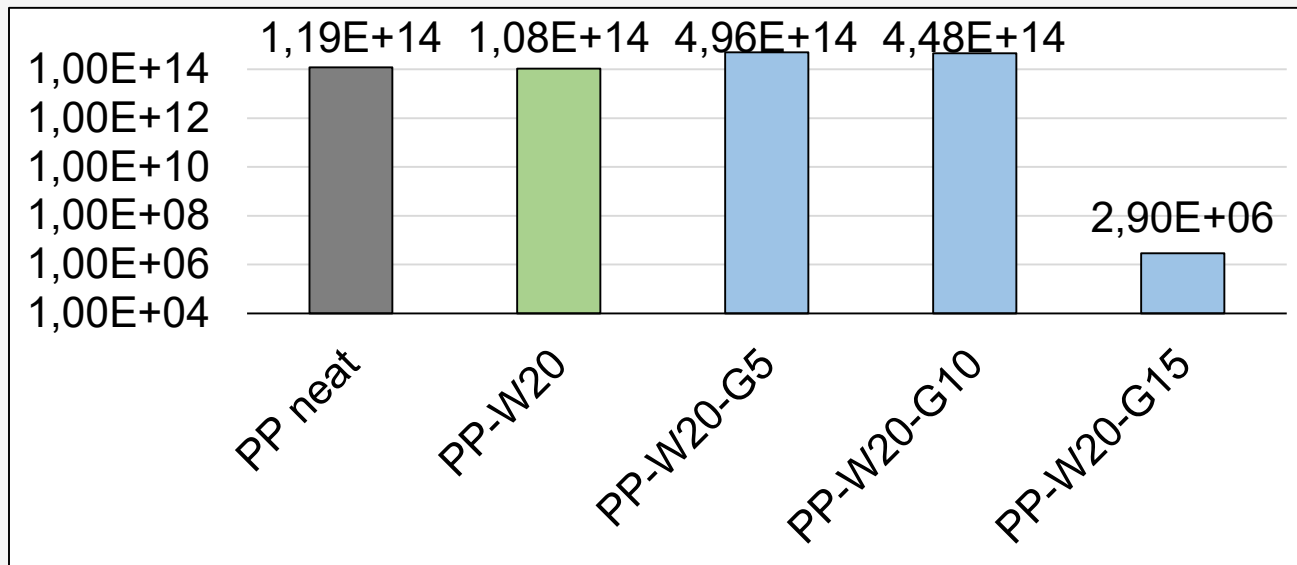
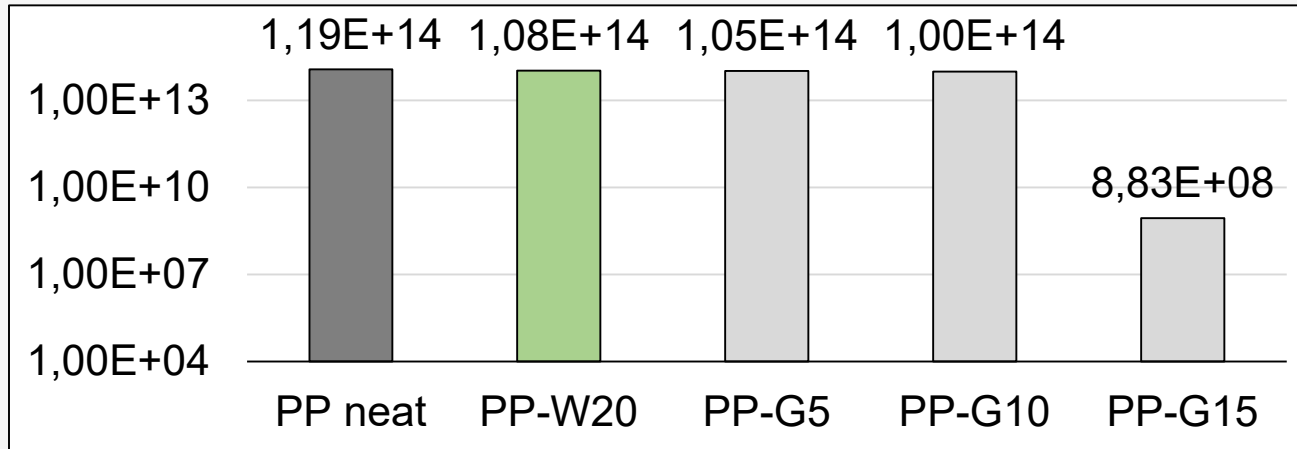
- Co-rotating twin screw extruder
- Extrusion temperature: 190°C – 200°C
- Screw speed: 150 rpm
- Feed rate: 5 kg/h



## Hot pressing

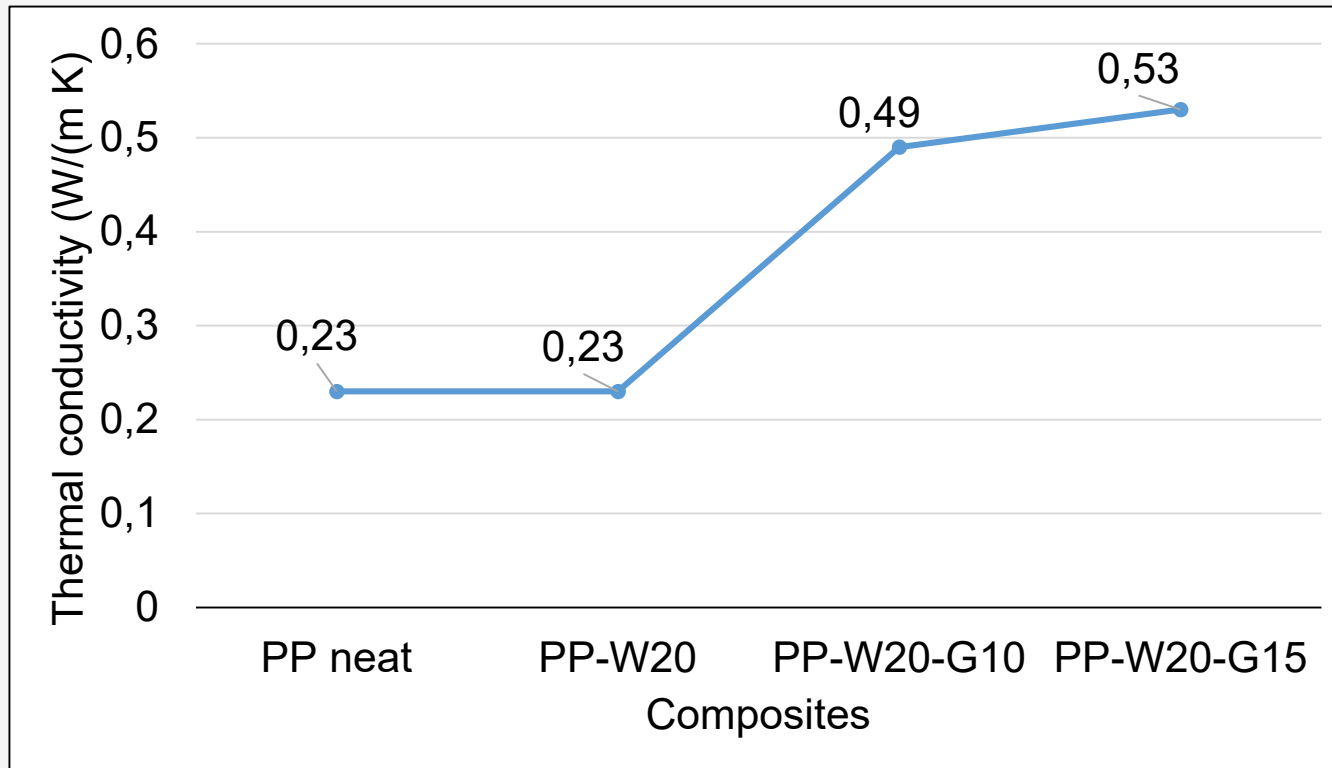
- Press time/temperature: 3 minutes/220°C
- Press load: 3.5 MPa
- Pre-heating time: 15 minutes

# Surface resistivity



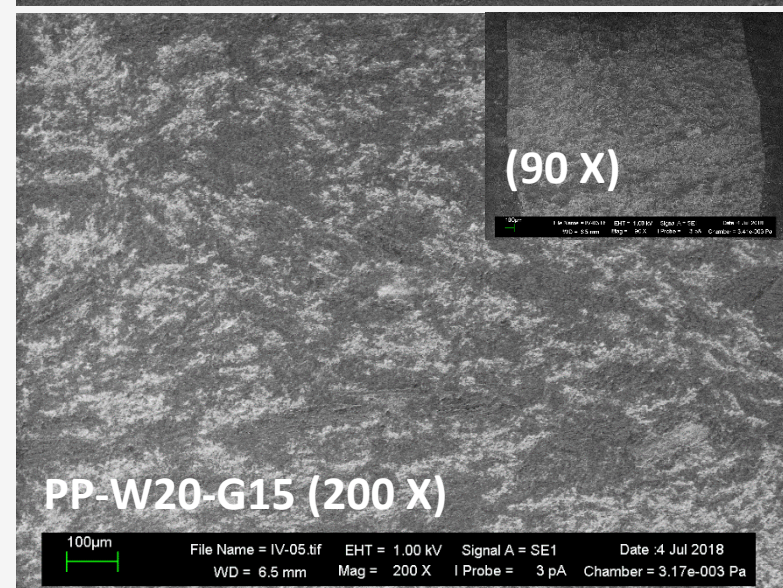
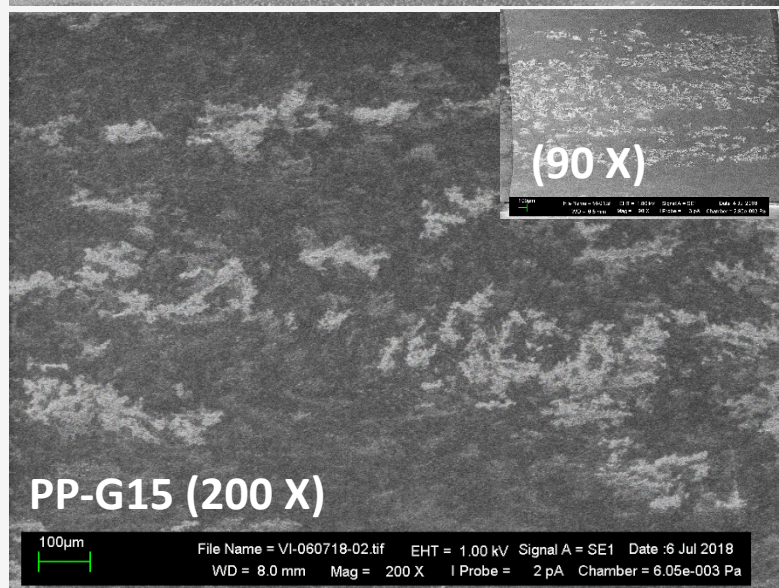
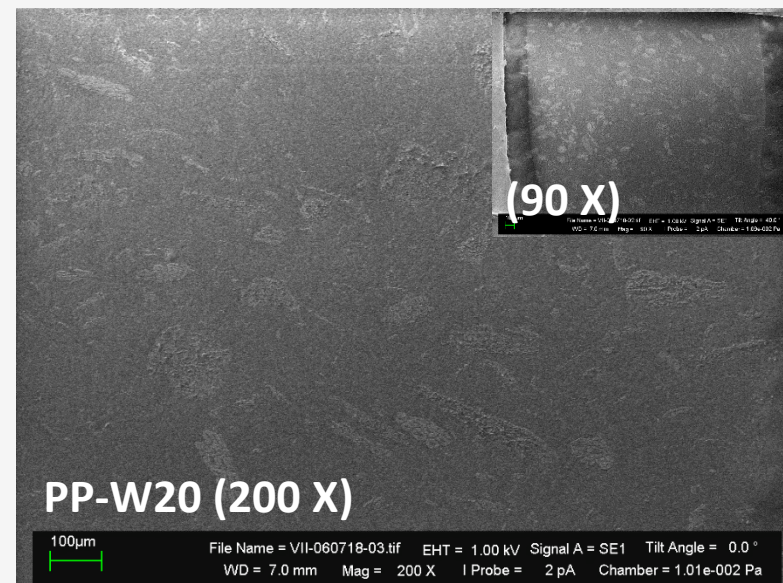
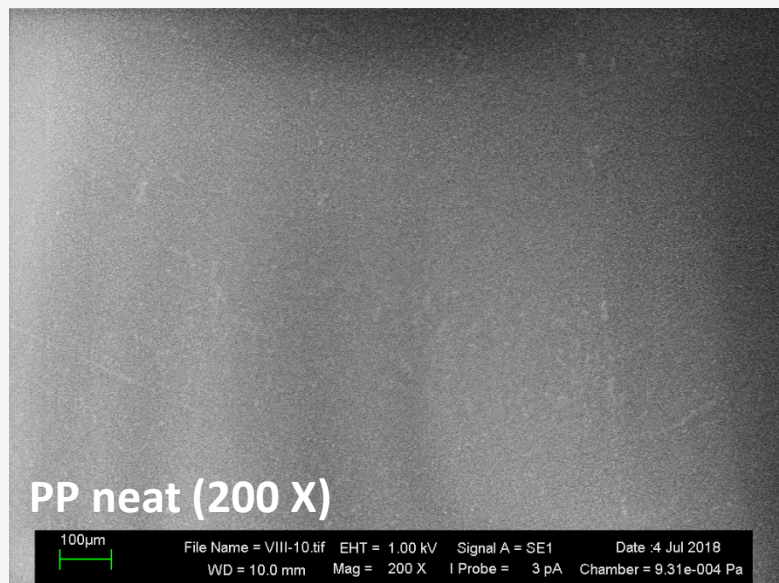


# Thermal conductivity

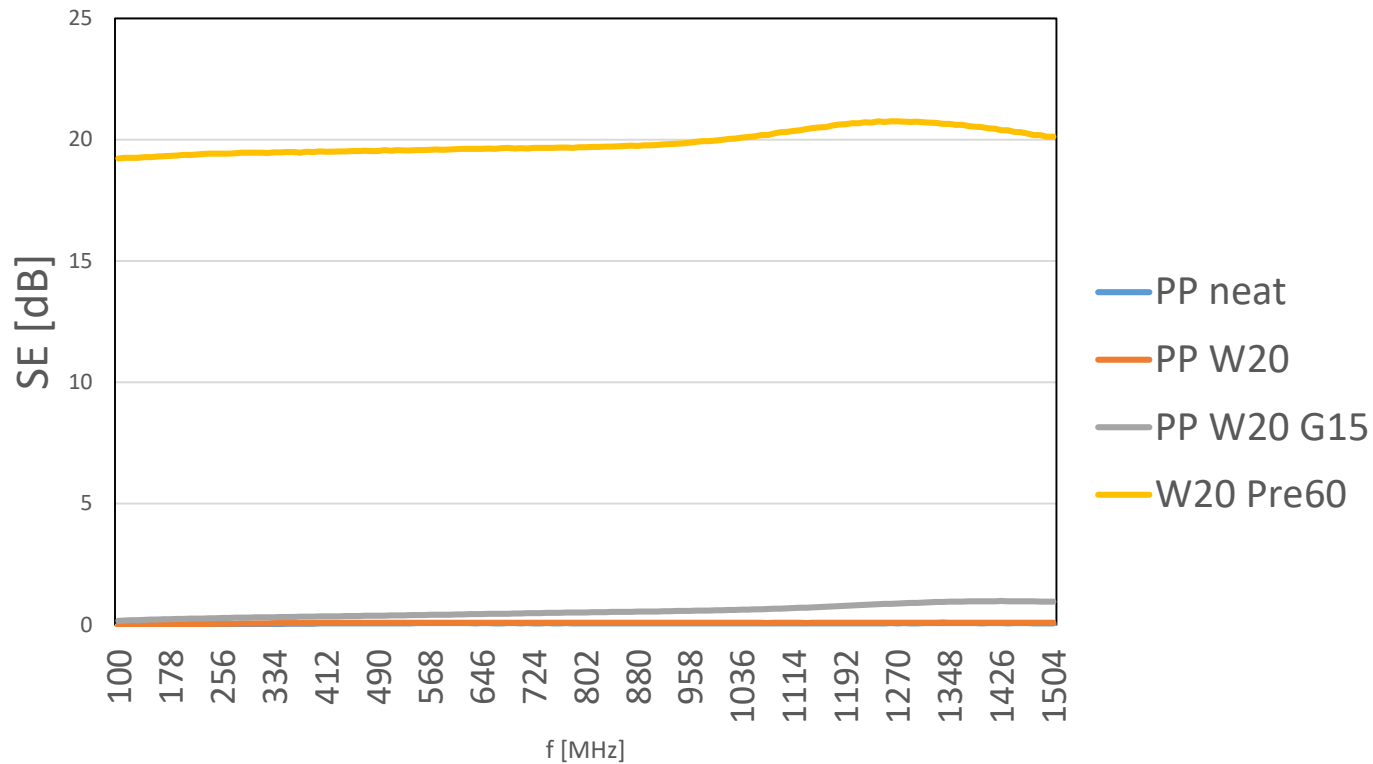


- Thermal conductivity of functionalized composites increased compared to PP neat

# SEM



# EMI-SE



# Applications

Electrically conductive plastic compounds are typically used for controlling static electricity or ATEX (explosive atmospheres) applications. The light-weight and easily processable electrically conductive plastics are also often replacing more expensive metals.

- Anti-static corrugated box
- Electrically conductive pipes and profiles
- Electrically conductive containers and canisters for clean room application
- Conductive WPC for EMI shielding applications

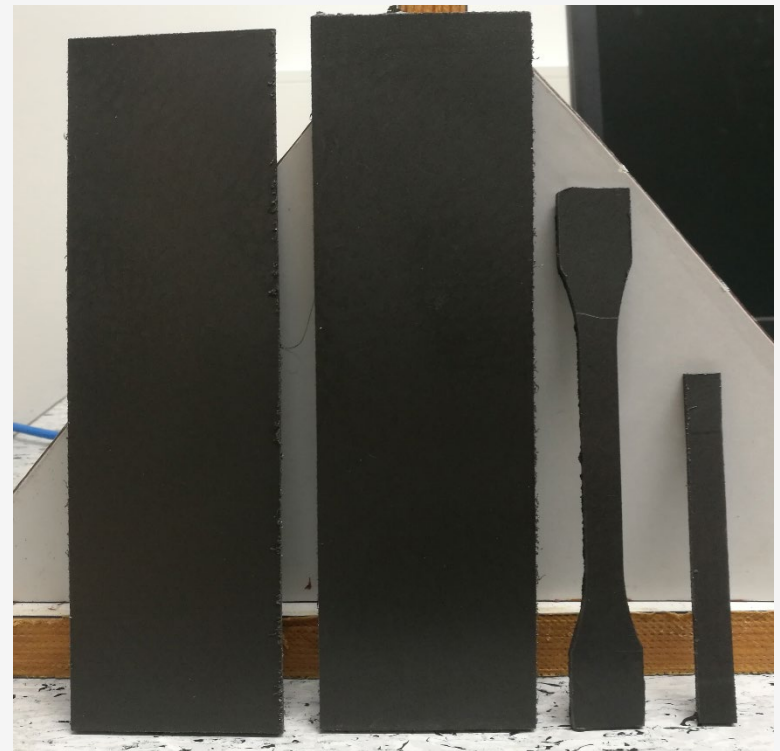
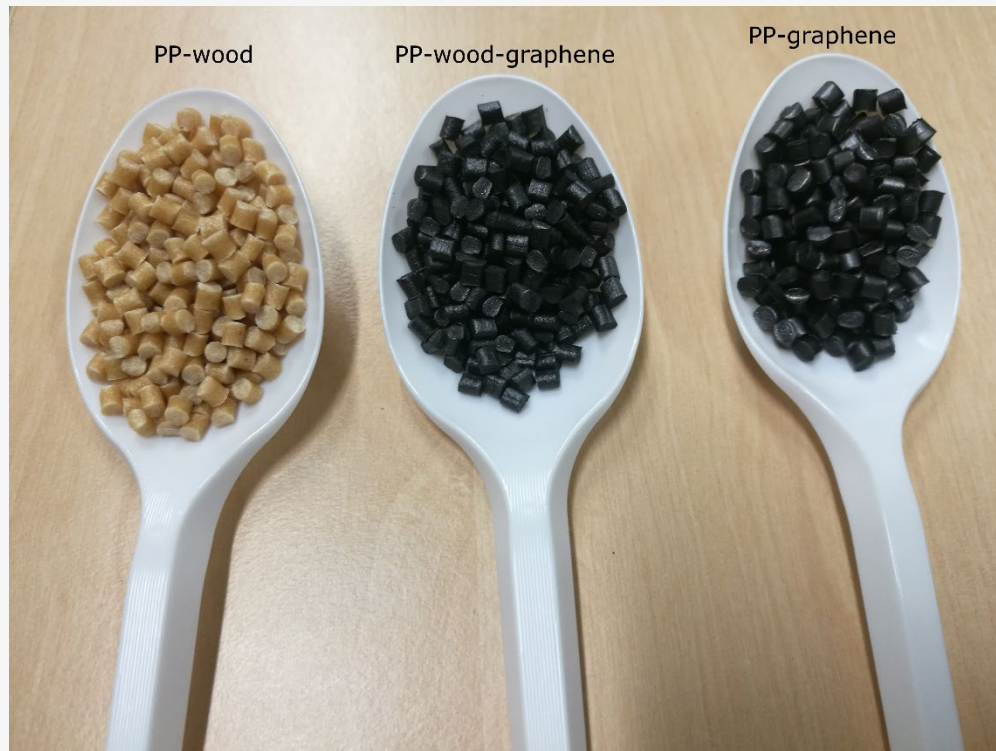


# Conclusions

- Bioplastics are sustainable solution for **food and beverages packaging**.
- Market share of **biodegradable polymers** are forecasted to increase in coming years
- **Forest industry waste and agricultural wastes** are a source for biofibres for biocomposite production
- **Wood plastic composites are recyclable** 4-6 times and remains as source for energy recovery at end of life stage
- An **anti-static composite** was developed by melt mixing of PP-wood with 15 wt% graphene and an **electrically conductive** WPC is developed with EMI-SE of 20 dB by incorporating conductive carbon black
- More studies will be done with **PP-wood composite containing carbon black**

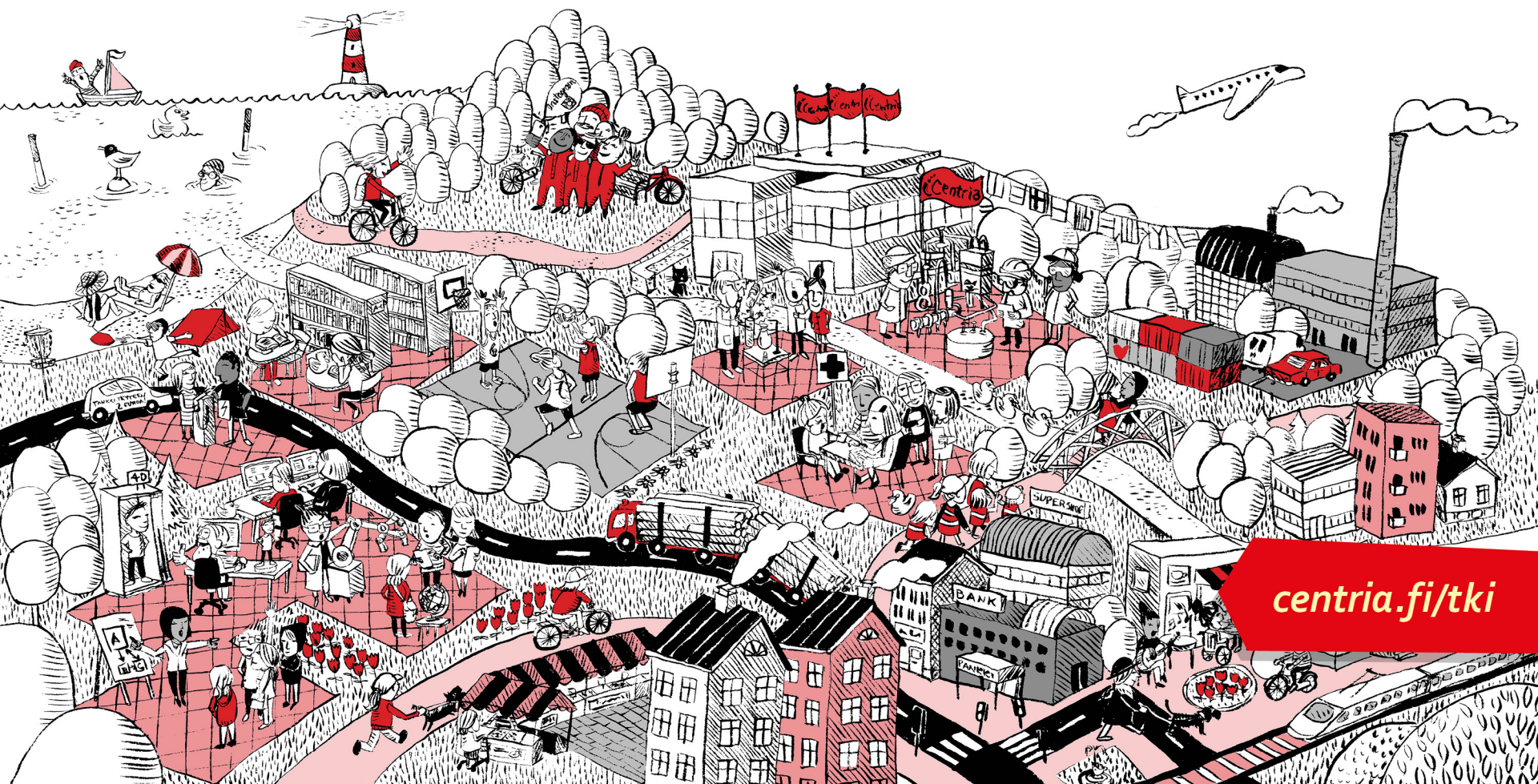


# Antistatic WPC





# Thank you



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