Norway grants

NCBR
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TWO-LAYER WOOD-BASED COMPOSITE WITH FIRE-RESISTANT CELLULOSE-CARBON CORE

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IPPS 2023 October 3rd

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PARTNERZY:

Uniwersytet Przyrodniczy w Poznaniu
Poznań University of Life Sciences

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CELLMAT4EVER

Fire protection through a coating

- Easy application
- The most popular fire protection solution on the market
- Improving the fire classification of wood-based materials to class B
- Transparent coating is available

- Several layers of coating is required
- Expensive
- Unstable in outdoor use (leachable)
- Not suitable for materials which are thinner than 12mm
- Hight dens product (>700kg/m^3)

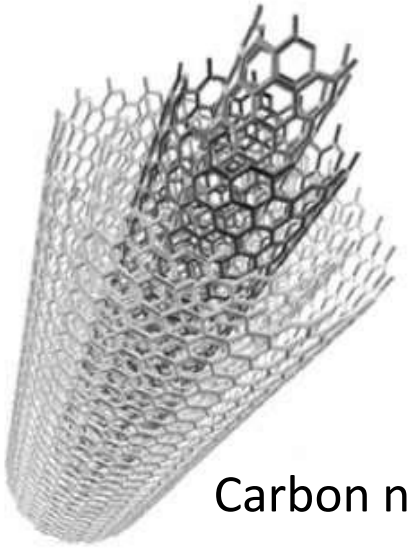
Fire protection through deep impregnation

- Not really expensive
- Well-known on a market
- Improving the fire classification of wood to class B
- Does not change the color and texture of the wood

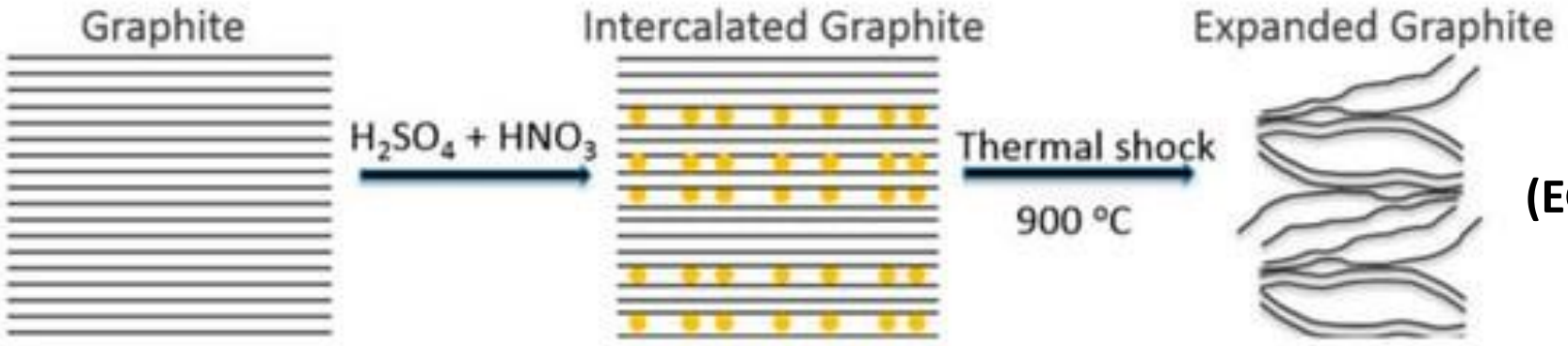
- Expensive equipment required
- Unstable in outdoor use (leachable)
- Not suitable for materials which are thinner than 12mm
- Hight dens product (>700kg/m^3)

Do we know any alternative solution?

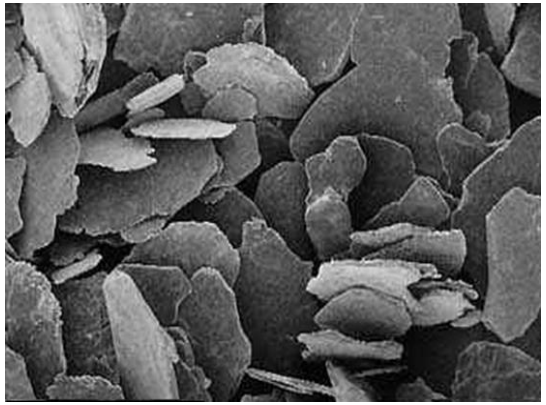
Electronic industry



Carbon nanotubes **(CNT)**



(EG)



What are the challenges for EG and CNT as flame retardants?

How fixed non-water soluble carbon particles in a wood-based products?

What advantages should the new material have?

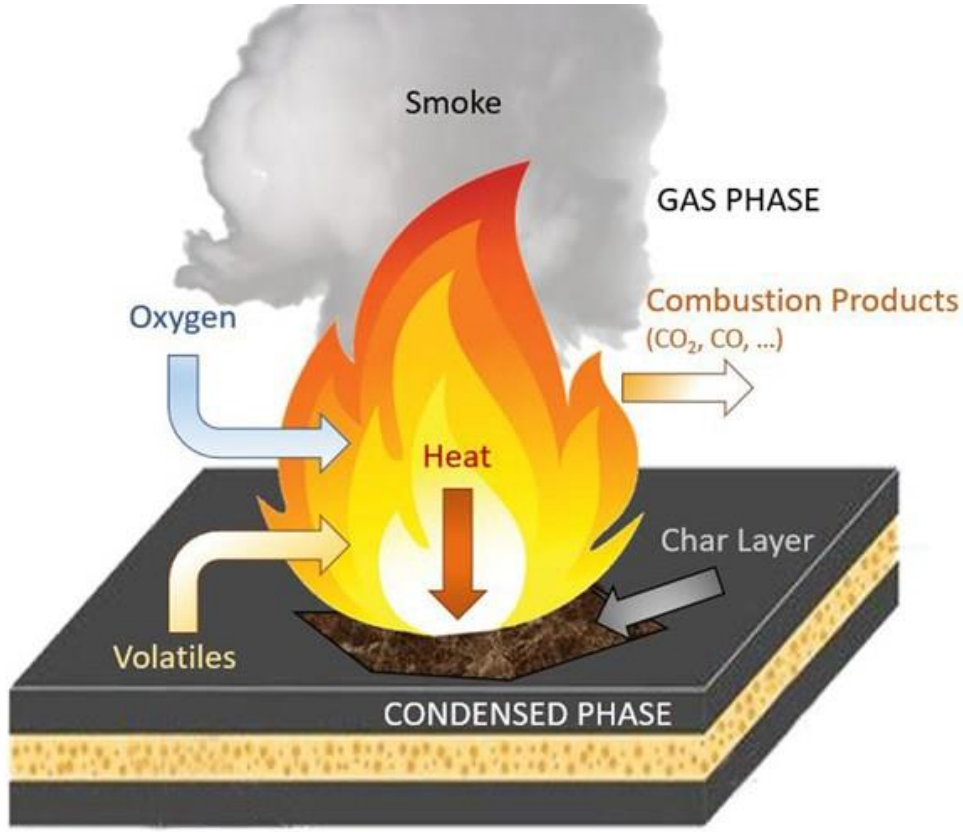
Thin two-layer composite
Potential possibilities to get „EuroClass B”

Aim

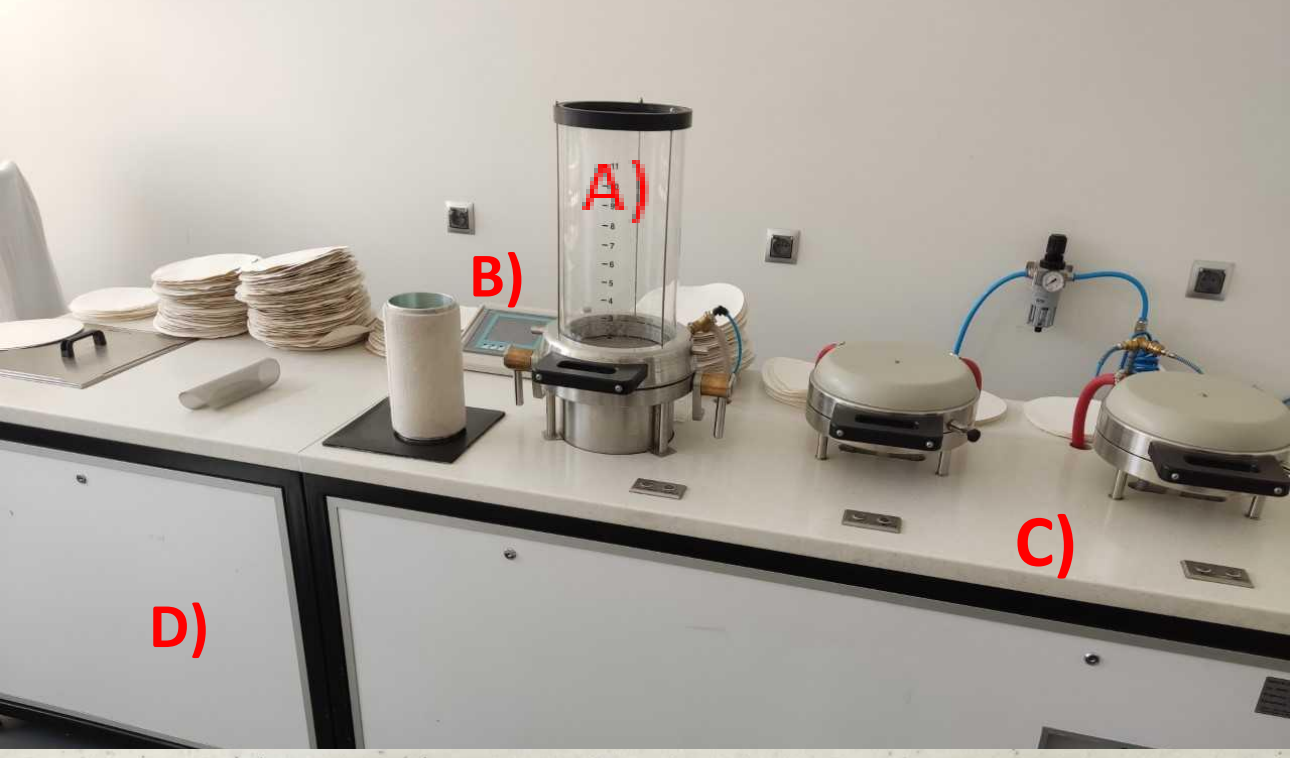
Developing thin two-layer composite materials (with a maximum thickness of 5 mm) showing the potential of the classification Bs1,d0 according to EN 13501-1

Scope of the work

- production of a two-layer composite (containing EG and CNT in a cellulose matrix, and pine veneers as outer layers)
- Mini Fire Tube analysis
- Mass Loss Calorimetry analysis



https://www.compositesworld.com/articles/measuring-and-improving-fire-resistance-in-composites



Rapid-Kothen sheet former

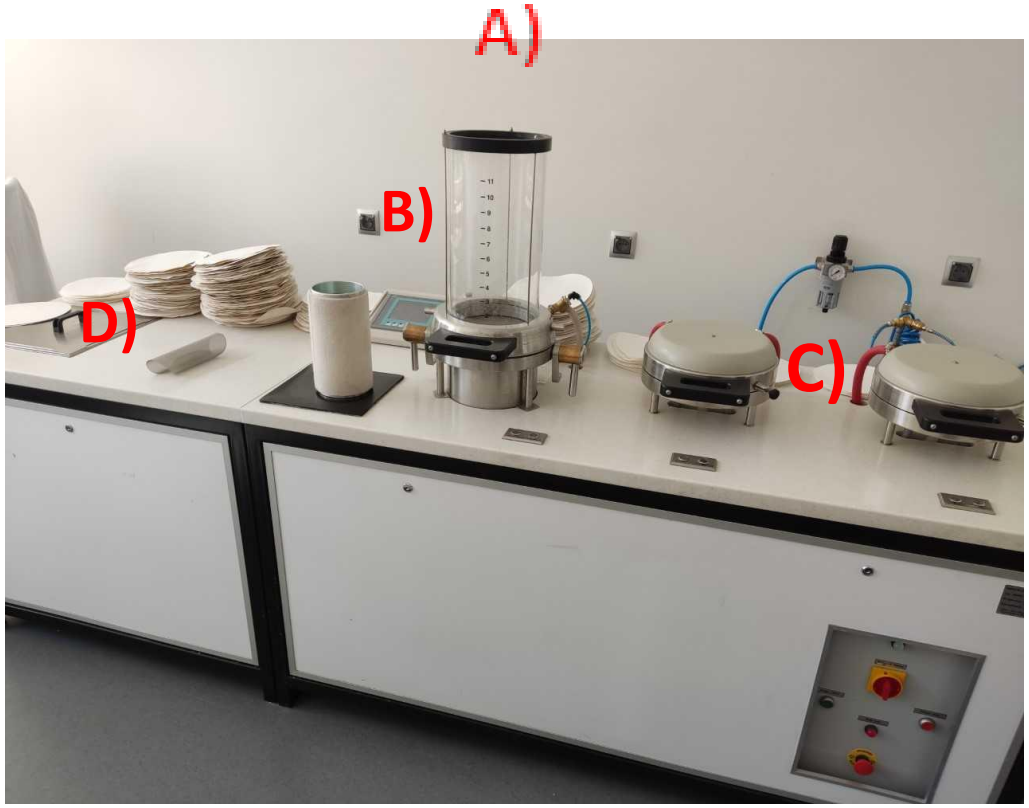
A) sheet forming area;

B) control panel;

C) vacuum drying area;

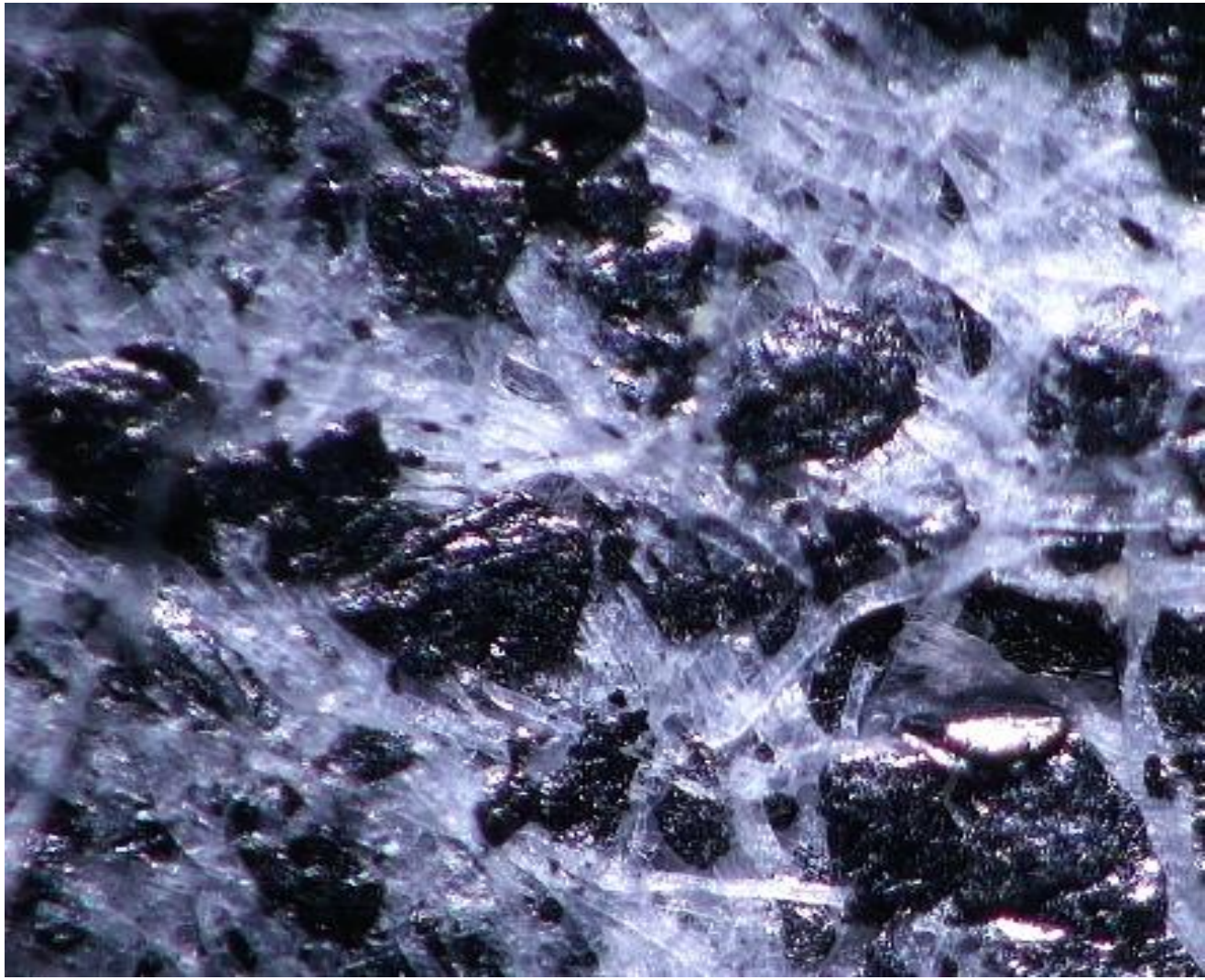
D) container of post-process water;

Method – step by step



1) Pulp preparation (fibres soaking; modification; defibrillation, etc.)
2) Fibres suspension application to R-K
3) Water application (tap or modified)
4) Additives supplementation
5) Stirring process (by air pressure)
6) Sheet formation (floating and vacuum)
7) Drying process

Effect of EG/CNT incrustation in cellulose matrix



Composite panel production

REF - reference samples – two layers of veneer without a middle cellulose layer (thickness of 1.73 mm);
C - control samples – two layers of veneer with an intermediate layer made of cellulose sheet (thickness of 1.82 mm);
M - composite samples – two layers of veneer with a middle layer made of a sheet of carbon-nanotubes/graphite modified cellulose in ratio 1:1:1

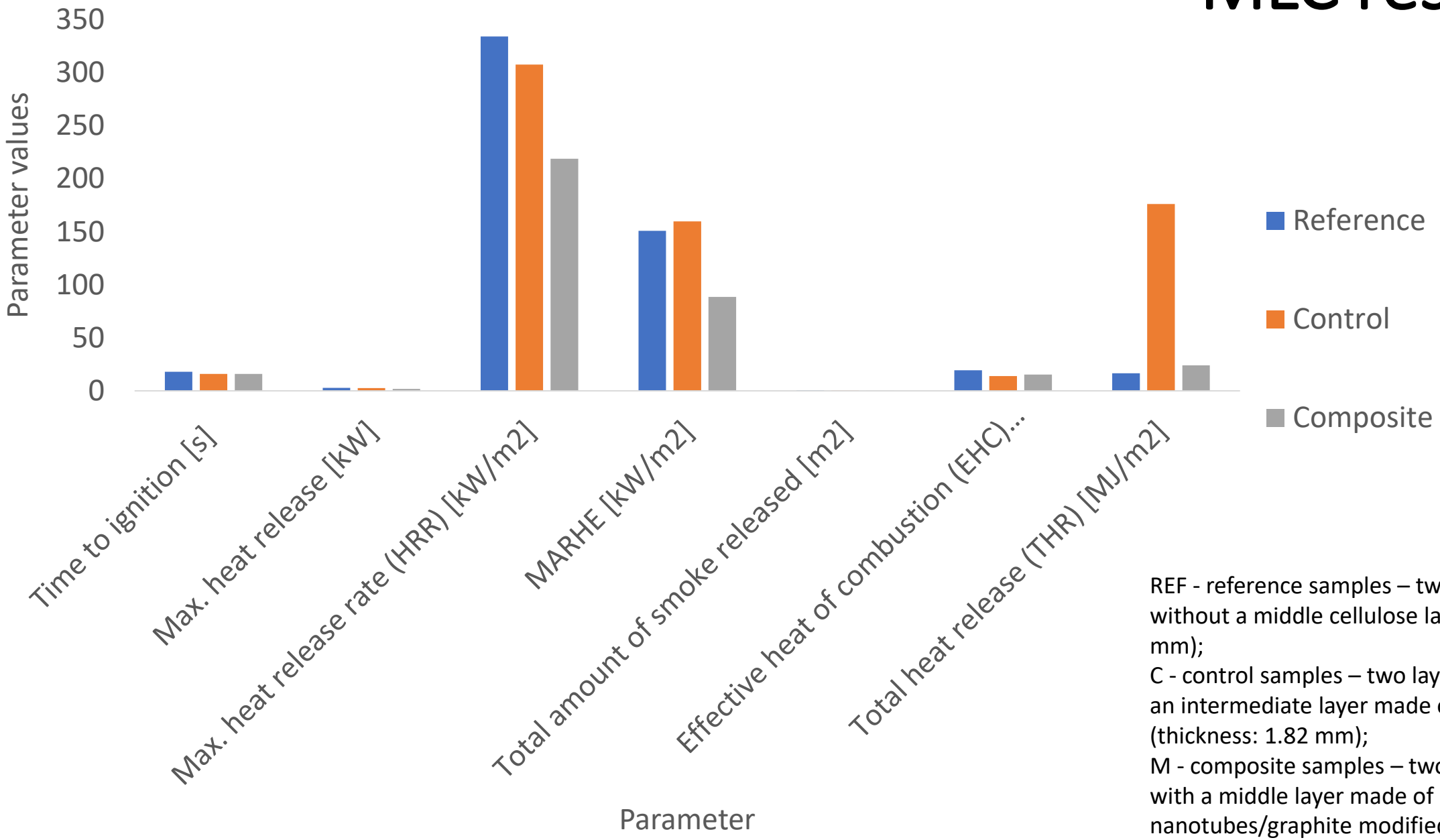
MLC analysis

- Heat flux - 50 kW/m^2
- Samples dimentions – 100 x 100 x 5 mm
- Test duration - 1200 s

Measured parameters

- Maximum mass loss rate [g/s]
- **Time to ignition [s]**
- Time to flameout [s]
- Maximum CO_2 concentration [%]
- Maximum CO concentration [ppm]
- **Max. heat release [kW]**
- **Max. heat release rate (HRR) [kW/m^2]**
- **Max. av. HRR (MARHE) [kW/m^2]**
- Max. light attenuation [%]
- Max. smoke produce rate (SPR) [m^2/s]
- Total smoke production per unit area of exposed specimen during the test duration [m^2/m^2]
- Total smoke production per unit area of exposed specimen [m^2/m^2] prior to ignition
- Total smoke production per unit area of exposed specimen [m^2/m^2] from ignition until flameout or the end of the test; equal to zero if ignition does not occur
- **Total amount of smoke released [m^2]**
- **Effective heat of combustion (EHC) [MJ/kg]**
- **Total heat release (THR) [MJ/m^2]**
- CO emission [mg/g]
- CO_2 emission [mg/g]

MLC results



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Conclusions

- The two-layer composite material with a thickness of approx. 4.5 mm showed higher fire resistance compared to the reference and control.
- The reduction in smoke production and emissions (almost four times) proves the high ability of the material containing EG/CNT to retain carbon in the structure

=> **development of environmentally friendly materials and improvement of fire classification**.

- The HRR peak was reduced by approximately 100 kW/m^2 and the MAHRE decreased to 90 kW/m^2

=> **the material is probably class C (acc. to EN 13501-1). However, it will be necessary to impregnate or coat external veneers to obtain class B**

- Research is still continued as part of the CellMat4ever project (www.cellmat.up.poznan.pl/en).

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Acknowledgements.
This research was co-funded by National Center for Research and Development, III edition of EEA and Norway grants; The Program' Applied Research in the frame of Norway Grants 2014-2021/POLNOR 2019 (NOR/POLNOR/CellMat4ever/0063/2019-00)

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