



PFA THERMOSETS IN COMPOSITE APPLICATIONS

EClass meeting June 26th 2018

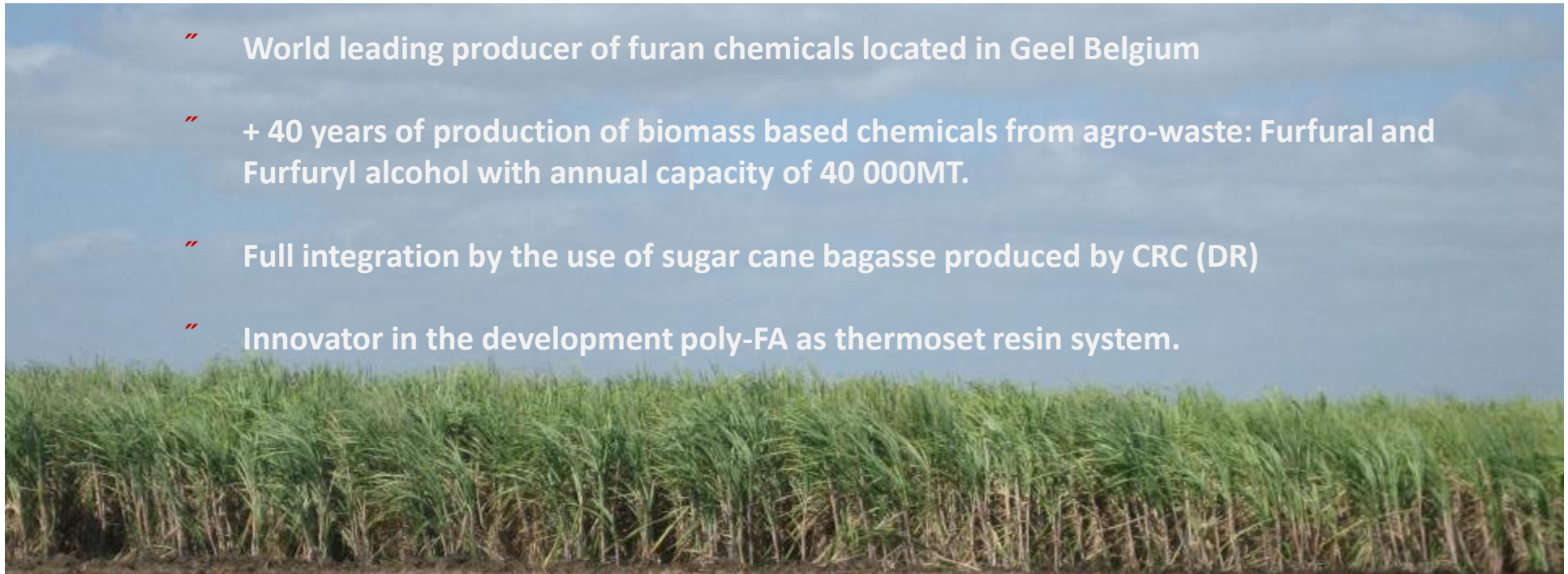
TransFurans Chemicals

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TransFurans Chemicals

- “ World leading producer of furan chemicals located in Geel Belgium
- “ + 40 years of production of biomass based chemicals from agro-waste: Furfural and Furfuryl alcohol with annual capacity of 40 000MT.
- “ Full integration by the use of sugar cane bagasse produced by CRC (DR)
- “ Innovator in the development poly-FA as thermoset resin system.



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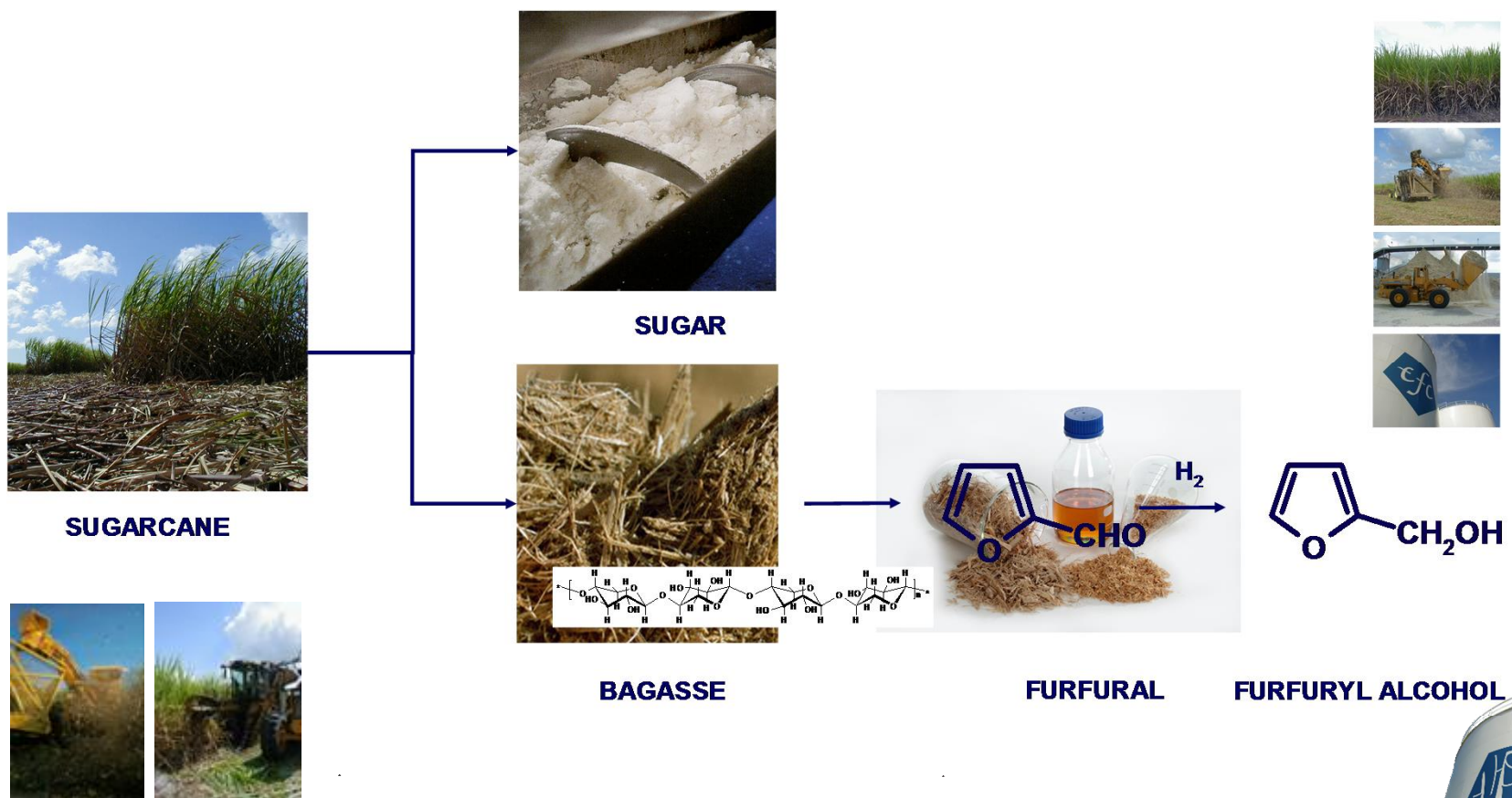


Our raw material

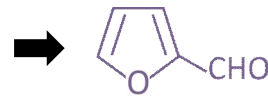
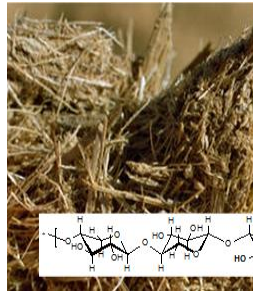


Furfural Chemistry

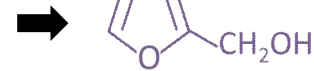
Utilization of agrowaste as feedstock



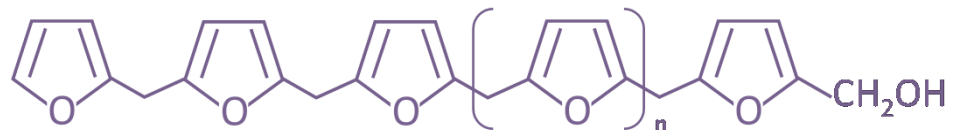
Polyfurfuryl alcohol thermoset/ PFA



FURFURAL



FURFURYL ALCOHOL

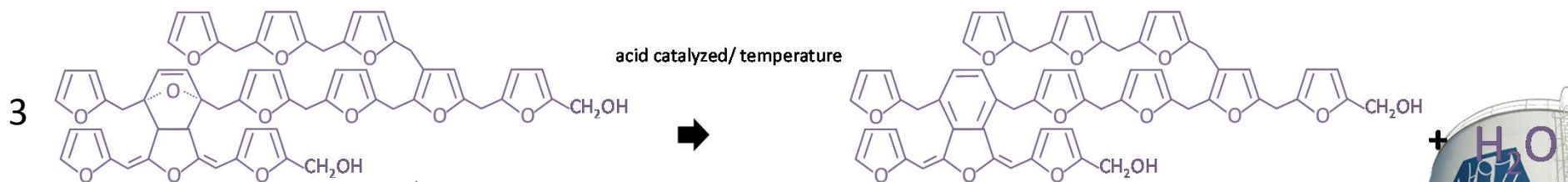
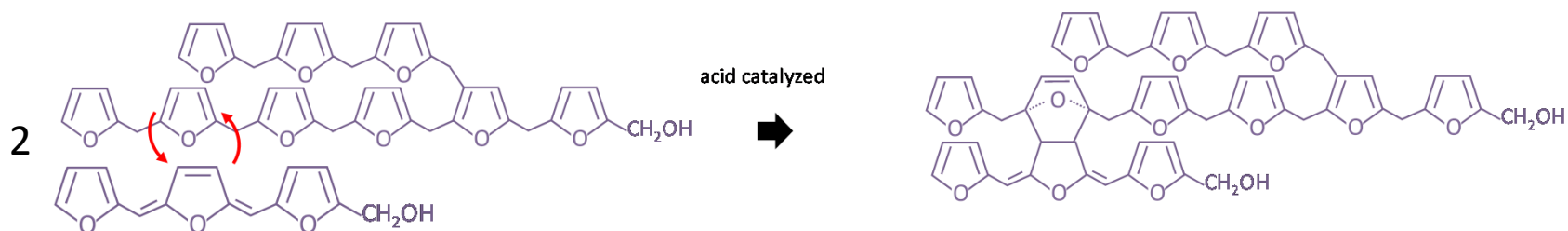
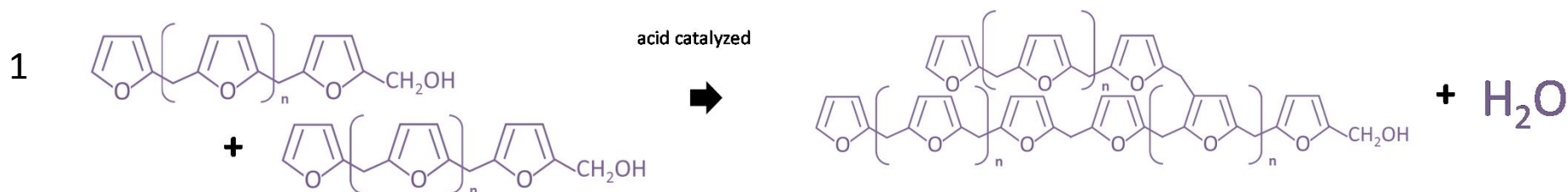


POLYFURFURYL ALCOHOL or PFA

- Liquid thermoset resin
- Curing by acid catalyst in multistep mechanism
- Uses water as dilluent
- Molecular weight dependant viscosities
- Temperature adjustable Tg



Polyfurfuryl alcohol thermoset/ PFA



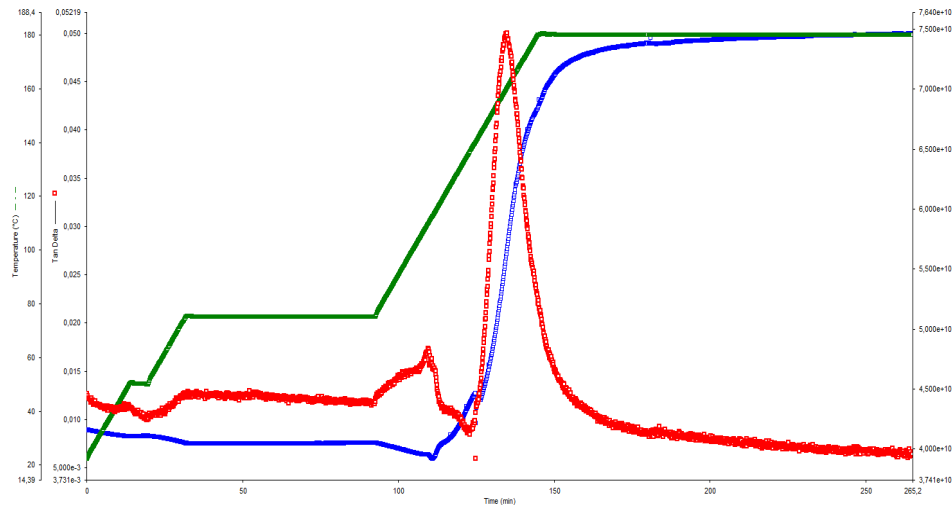
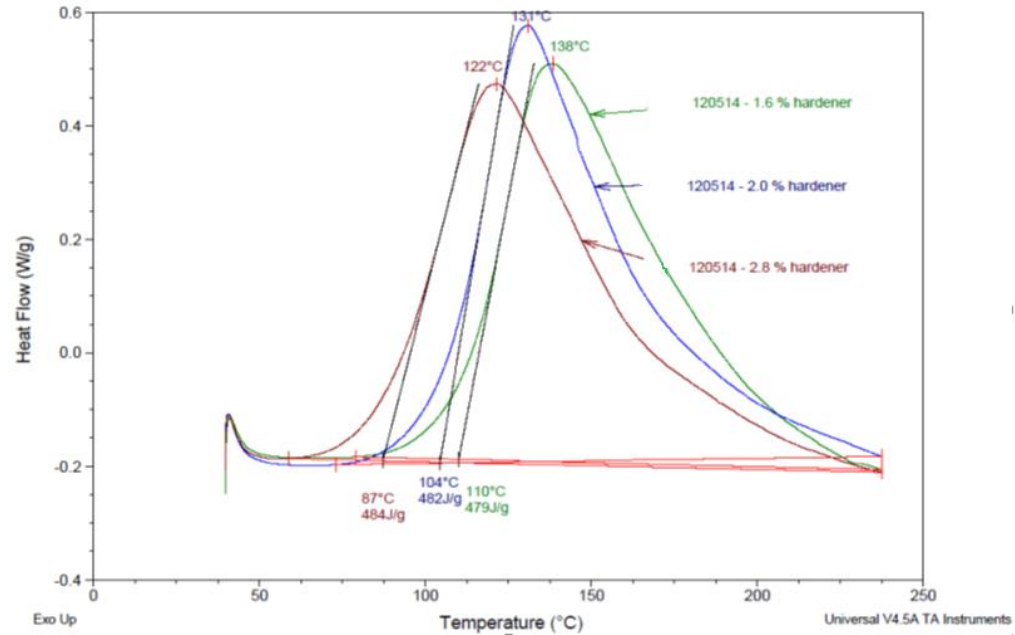
PFA Thermoset

“ Low temperature cure < 95°C

• INFUSION RESINS

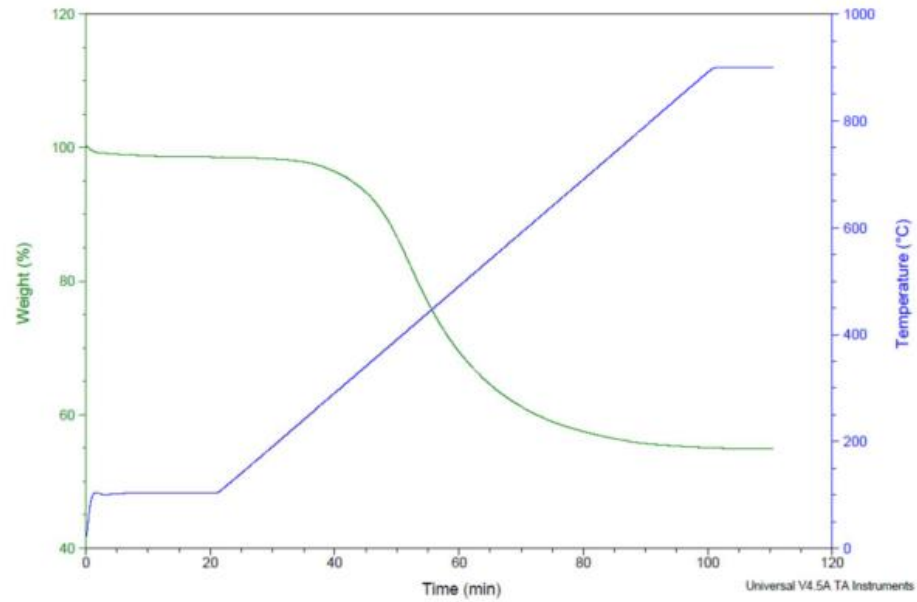
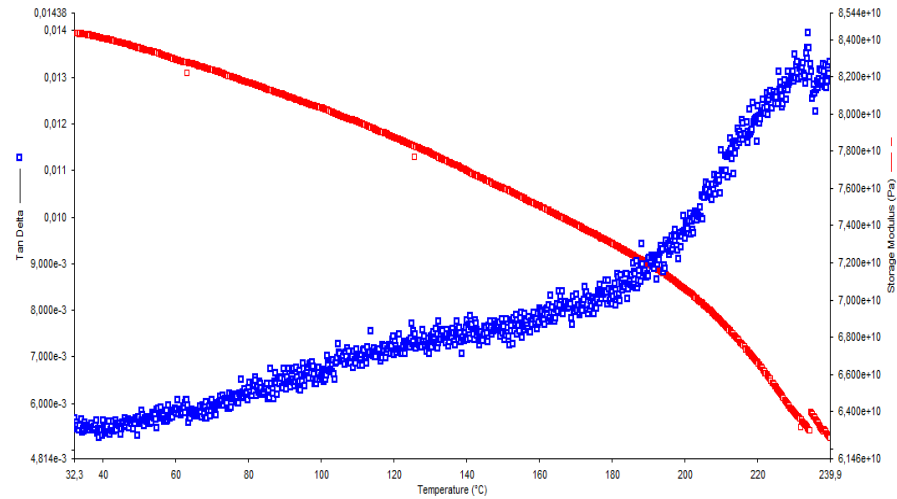
“ High temperature cure > 120°C

• PREPREG RESINS



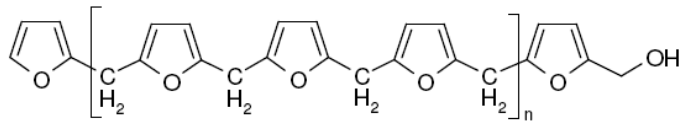
PFA Thermoset

- “ DMA thermal stability: $T_g > 180^\circ\text{C}$
- “ TGA thermal stability $> 200^\circ\text{C}$ (inert)

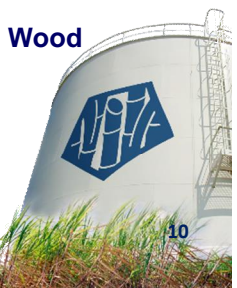
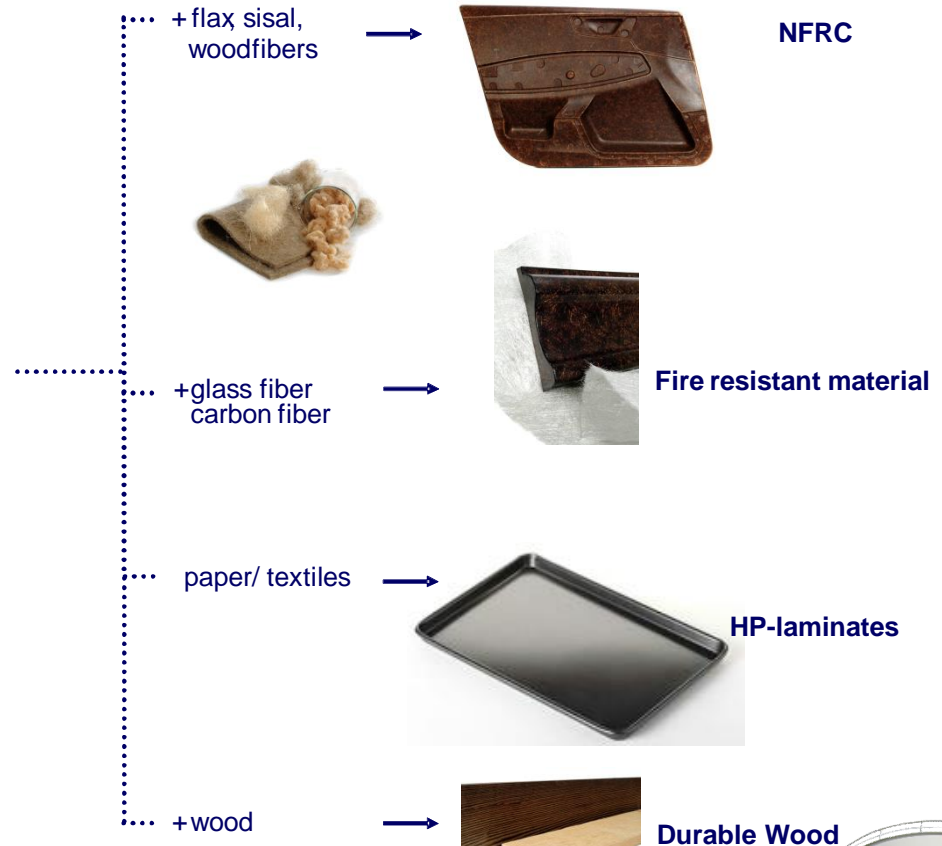


PFA Applications

PolyFurfuryl Alcohol/ PFA



- ~ Liquid thermoset systems
- ~ Available in VOC free formulation
- ~ Polycondensation biomass based thermoset with thermomechanical and FST properties like phenolic resins
- ~ Acid mediated curing mechanism
- ~ Available in various formulations
 - ~ Viscosity adjustment by water content (or FA)
 - ~ Curing adjustment by change of acid strength of the catalyst.



Fire-resistant composites

PREPREG : Glass PFA skins - Nomex core sandwich panel



after 60 secs

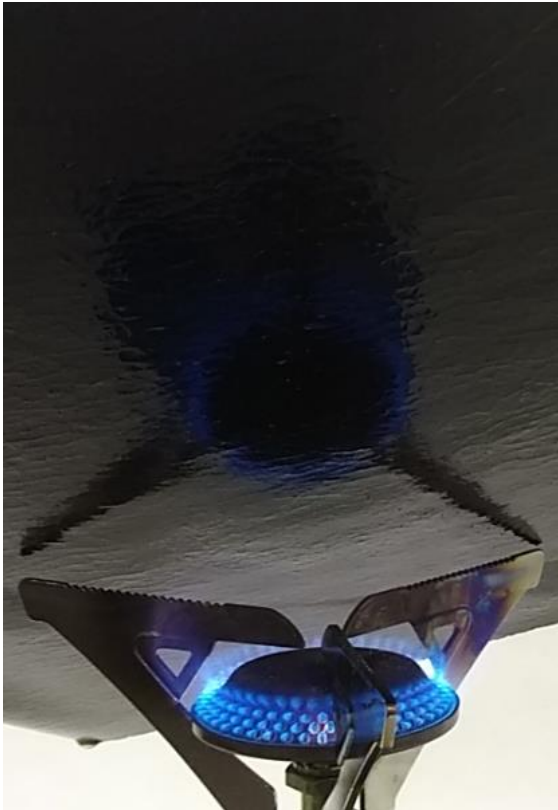


after 180 seconds



Fire-resistant composites

WET LAY UP : Glass CSM PFA monolithic laminate



at start



after 120 sec



after 180 sec



Fire-resistant composites

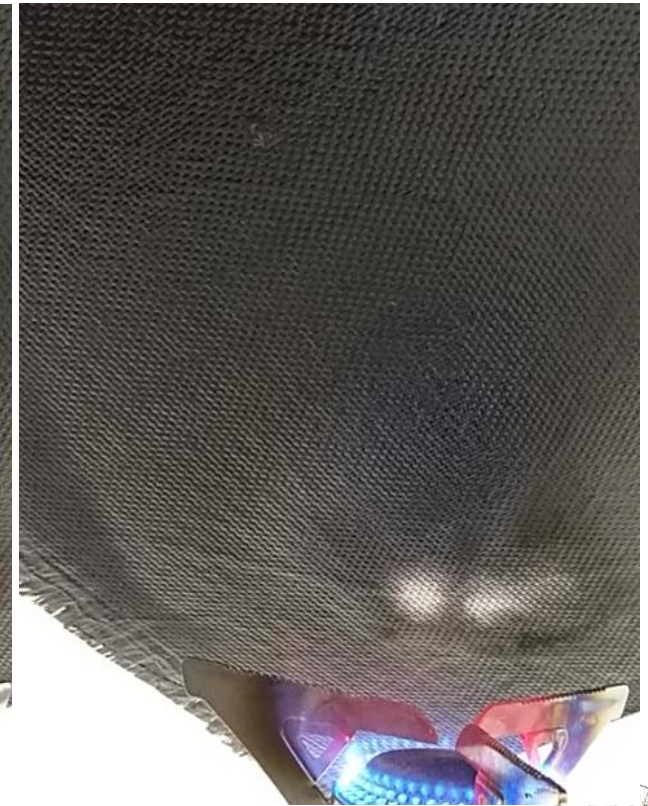
PREPREG : Glass PFA monolithic laminate vacuum out-of-autoclave consolidated



at start



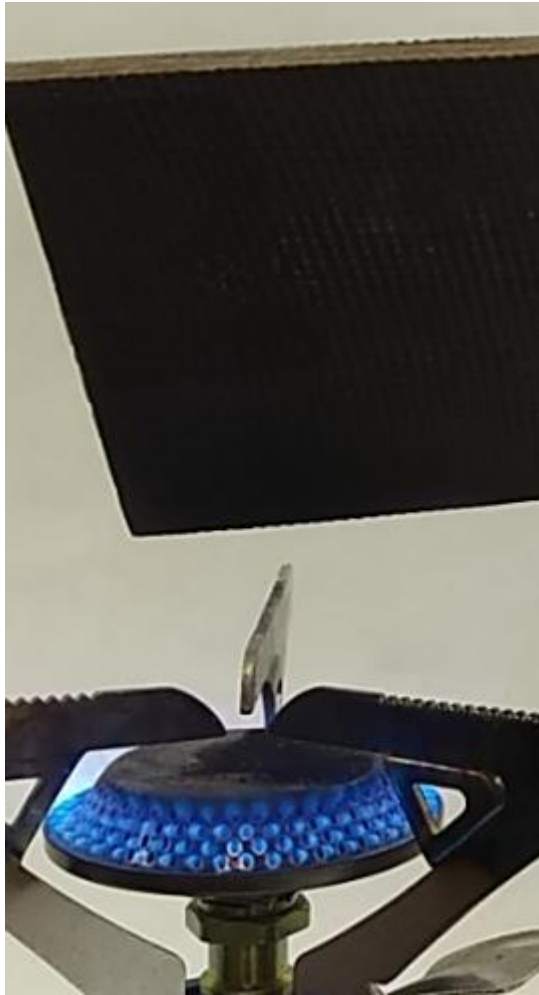
after 180 sec



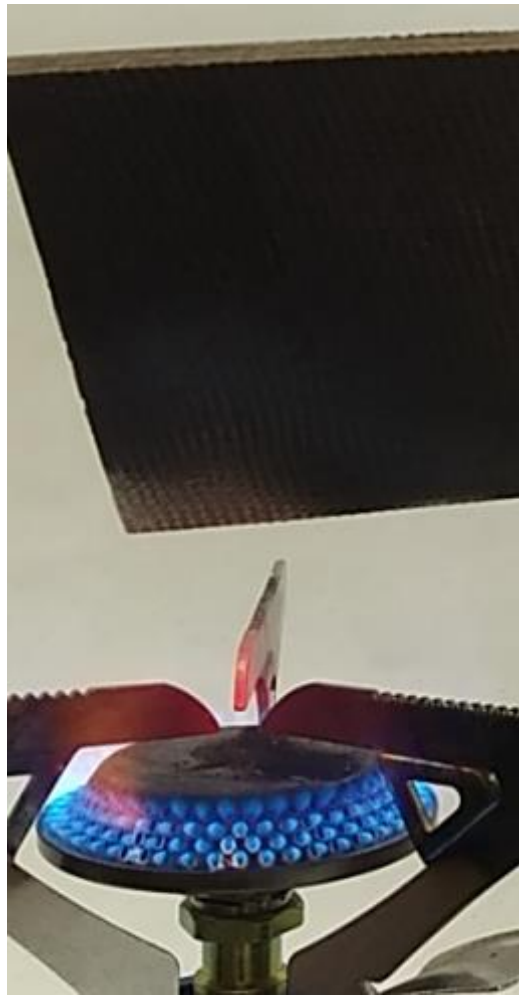
after 240 sec

Fire-resistant composites

PREPREG : Glass PFA monolithic laminate press consolidated



at start



after 180 sec

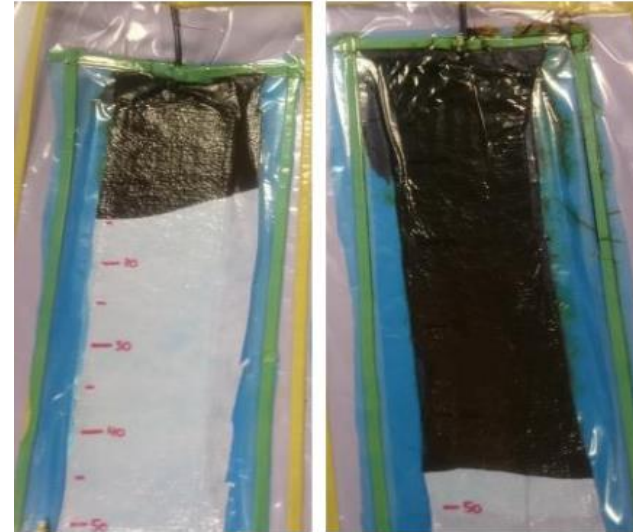


after 240 sec



Fire resistant composites: RAIL

- “ Technology developed for VARTM
- “ Allowing room temperature injection and curing at 80°C
- “ Application with mineral fibres.
- “ Yields a fire resistance specification of HL3 according EN45545

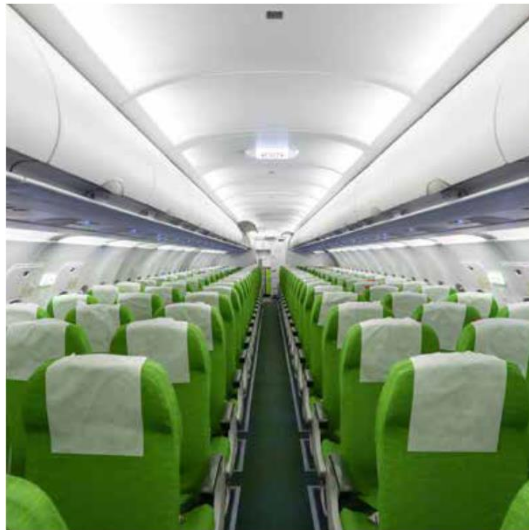
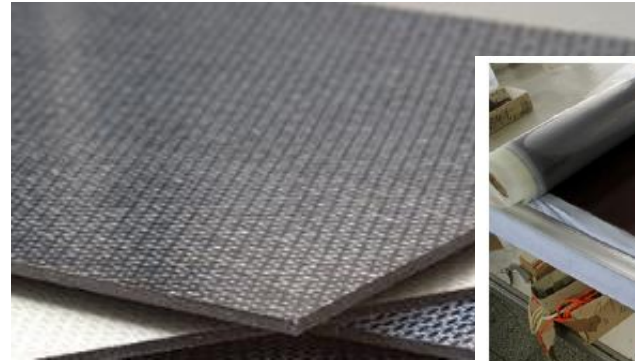


PFA infused glass fibre	EN45545 (50kW/m ²)
MARHE	40kW/m ² << 60kW/m²
LOI	35 to 40%



Fire resistant composites : Aerospace

- “ PFA resins applied in form of prepregs.
- “ Various application techniques using:
 - “ hot compression moulding
 - “ vacuum consolidation
 - “ autoclave consolidation



PFA 7781 glass prepreg consolidated at 140°C		
FAR 25.853 (a) Appendix F Part I	Flame Time: <<1 s	Requirement < 15 s
Flammability	Drip Flame Time: 0 s	Requirement < 3 s
	Burn Length: <1”	Requirement < 6”
FAR 25.853 (a) Appendix F Part IV	Peak: 30-40 kW/m ²	Requirement < 65 kW/m ²
Heat Release	Total: 30-40 kW/m ²	Requirement < 65 kW/m ²





fire performance of high performance polymer matrix composite materials for the transport sectors



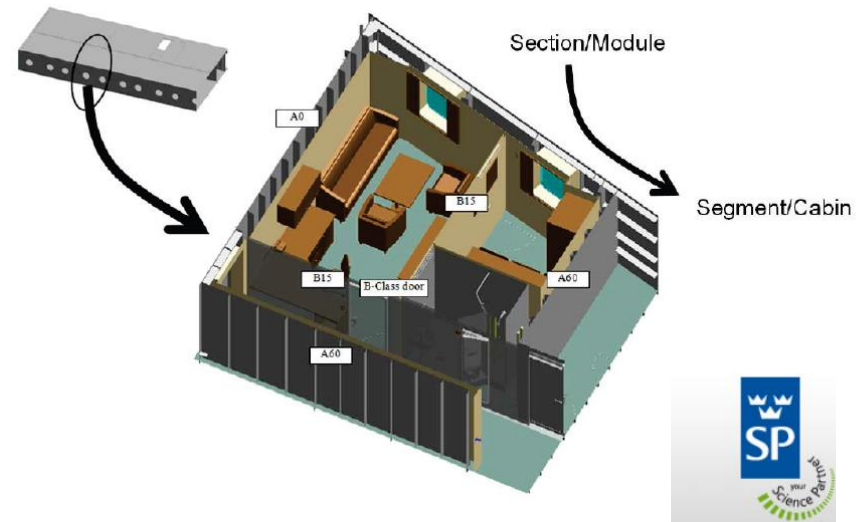
Marine: Bulkhead demonstrator



intumescent coating

core cork layer

PFA laminate

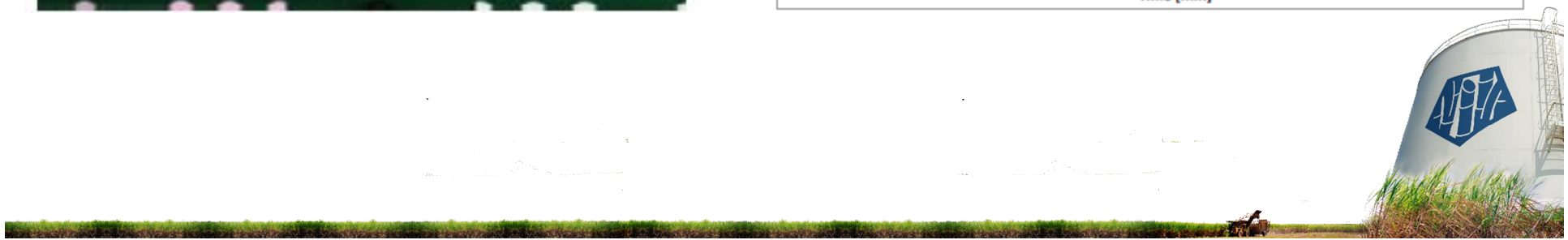
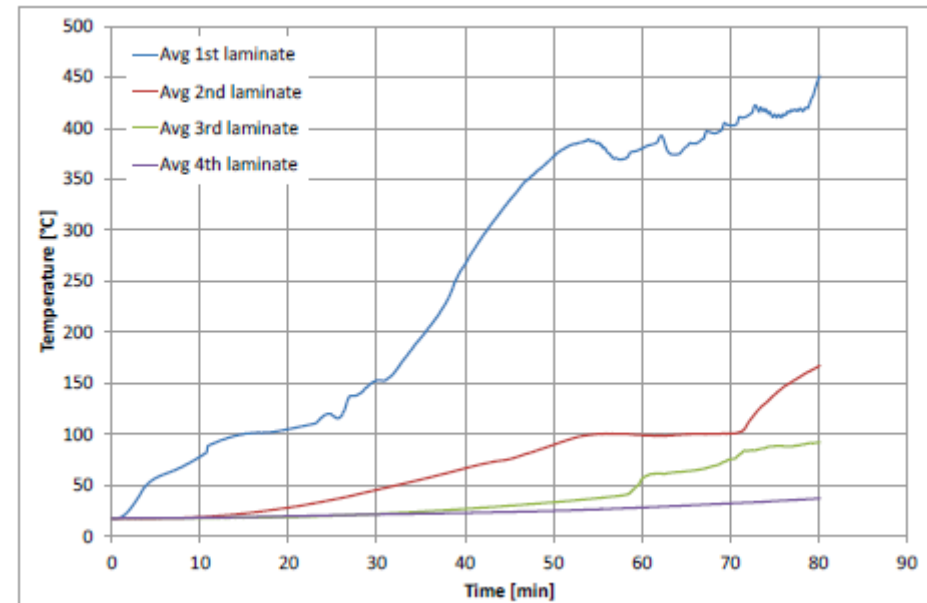
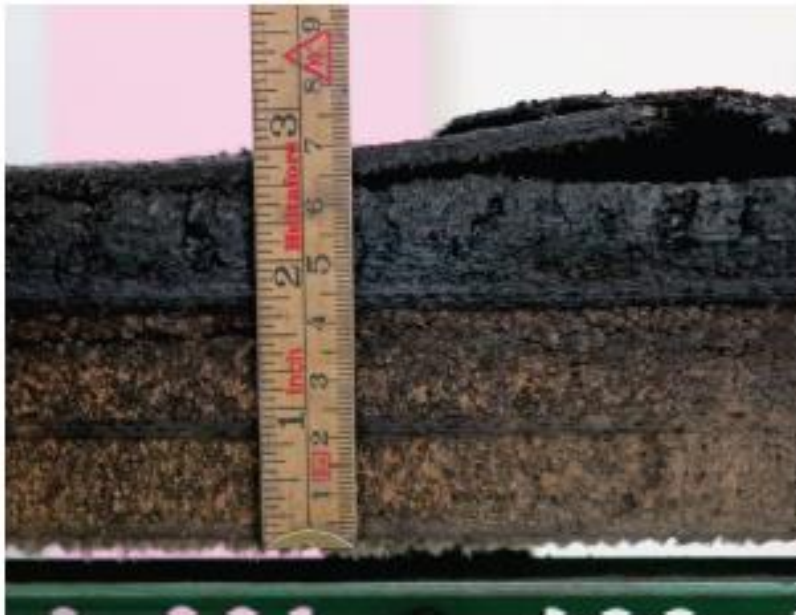


FTP code IMO, "2010 FTP Code: International Code for Application of Fire Test Procedures, 2010", 2012 edition, International Maritime Organization, London, 2012.

- Fire resistance of at least FRD60 according to Part 11 in the FTP-code [2];
- o Load bearing capacity; **7 kN/m vertical load for 60 minutes**
 - o Insulation, after 60 minutes;
 - ☑ Average temperature rise on unexposed surface < 140 °C
 - ☑ Individual temperature rise on unexposed surface < 180 °C
 - o Integrity, for 60 minutes;
 - ☑ No flaming on the unexposed face



Marine: Bulkhead demonstrator



Marine: Bulkhead demonstrator



Large scale furnace test



Start @ 7kN/m load



Failure @ 7kN/m load after 77min





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BIOMASS BASED CHEMICALS

