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Thermoplastic matrix systems for large marine structures

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Thermoplastic matrix systems for large marine structures

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Part of the INTERREG 2Seas program which is part financed by the European Regional Development fund

GOALS



Drive for innovation
in new composite
materials

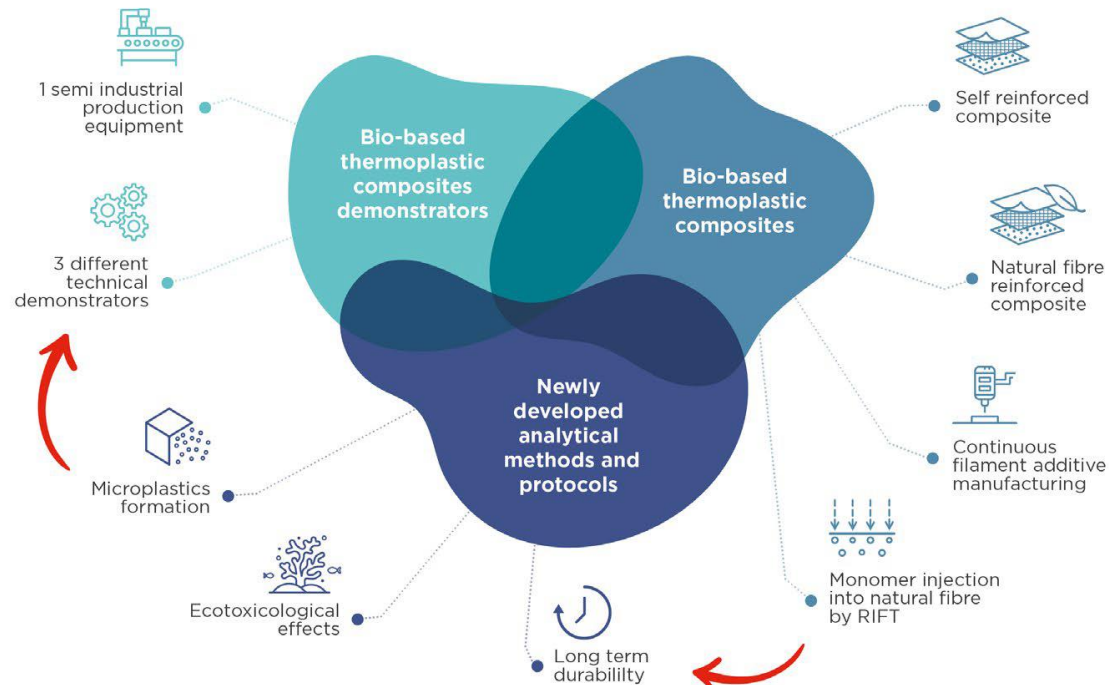


Reduce the
environmental impact
of composite maritime
industry components



Evaluate durability
and long-term ecological
impact from microplastics

DEVELOPMENT AND DEMONSTRATORS OF DURABLE BIOBASED COMPOSITES FOR THE MARINE ENVIRONMENT



InterReg SeaBioComp project

natural fibres in
bio-based thermoplastic

Sign up for the Interest Group
to be kept informed of
results, events, activities, etc.

[http://www.seabiocomp.eu/
interest_group/](http://www.seabiocomp.eu/interest_group/)

Large thermoset composite marine structures

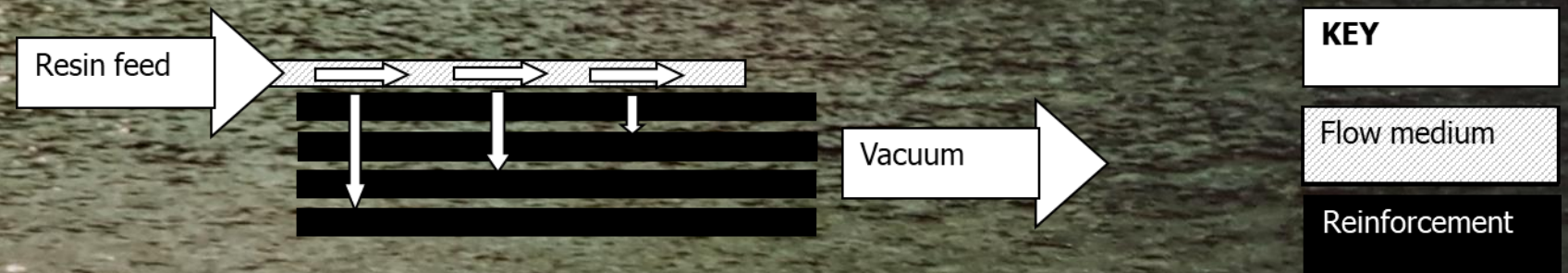
- vessels up to ~75 m overall length
 - Visby stealth corvette, M5 (was Mirabella 5) yacht
- offshore wind turbine blades to 114 m
 - Siemens Gamesa SG 2.1-114



Images from <http://www.mirabellayachts.com/mirabella5/>
<http://www.kockums.se/News/photostock/photosurface.html>
<https://www.siemensgamesa.com/en-int/products-and-services/onshore/wind-turbine-sg-2-1-114>

Resin infusion under flexible tooling with a flow medium (RIFT II)

- mould tool and membrane counterface
- long-range flow using a surface flow medium
- ideal viscosities from 200-1000 mPa.s



Monomer infusion under flexible tooling: (MIFT) = *in situ* polymerisation process

- thermoplastic melt viscosity too high
- monomers are potentially usable
- make polymer during composite manufacture

Monomer selection

Essential characteristics

Liquid monomers

YES

Viscosity suitable for infusion
(10-1000 mPa.s)

YES

Process temperature < 200°C:
no damage to natural fibre

YES

T_g > use temperature:
for structural applications

YES

Low water uptake:
avoid matrix plasticisation

YES

Desirable characteristics

Bio-based monomer

YES

Long process open time
for large structures

YES

Sensible cost/kg

YES

Low embodied energy and
environmental burdens

YES

Recyclability

YES

Sustainable infused marine composites

Icons from <https://icons8.com/>



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Potential systems

- cyclic butylene terephthalate (CBT) oligomers ✗ process temperature
- BPA polycarbonate ✗ process temperature and high viscosity
- lactam to polyamide ✗ wet Tg close to use temperature
- lactide to PLA ✓ meets outline criteria
- MMA to PMMA ✓ meets outline criteria

monomer selection paper under review



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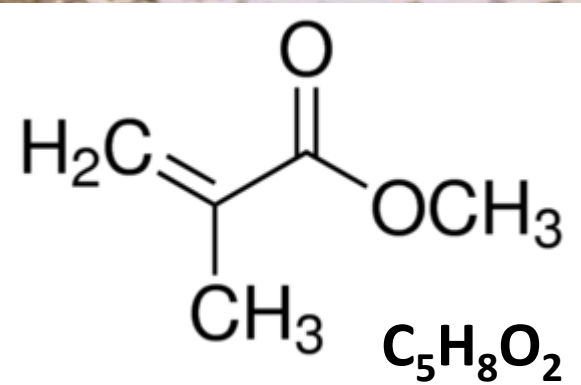


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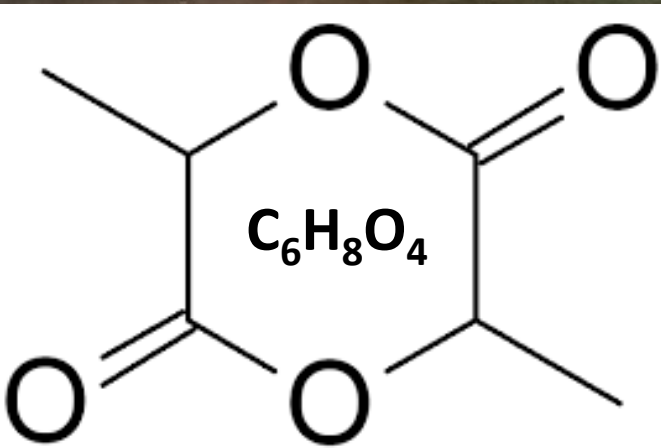
Methyl methacrylate

- addition polymerisation: no co-products
- “drop-in” substitute for resin processing
- bio-based monomer not yet commercially available
- material recovery low in end-of-life hierarchy



Lactide

- ring-opening polymerisation: no co-products
- high temperature (typically 120-180°C) processing
- bio-based monomer by default
- melt reprocessing high in end-of-life hierarchy



D 1.4.2	3D mould tool development	Mould	1	28/02/2021	31/05/2021	U Ply	Creation of a 3D mould tool with sensible temperature uniformity.
D 1.4.3	Report about the optimisation of tool design and RIFT process	Report	1	30/06/2021	30/09/2021	U Ply	Report on tooling and process parameters for components fabricated by resin infusion under flexible tooling with a flow medium using in-situ polymerisation of a monomer to produce a thermoplastic matrix composite.

Demonstrator component

- demonstrator component to be decided
- 3D mould tool with sensible temperature uniformity
 - completion deadline 31 May 2021
- optimised tool design and process for MIFT composite component
 - completion deadline 30 September 2021

Open to suggestions:
1 m square by 500 mm high?

Summary

in situ polymerisation
during MIFT for large marine structures

- methyl methacrylate
 - “drop in” option/ambient temperature
 - bio-based not yet commercially available
 - lower in the recycling hierarchy
- lactide
 - high-temperature process
 - bio-based by default
 - melt reprocessible



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