

Novel testing procedures for tidal composite blades

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Introduction

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The tidal blade material considered within the Nemmo project consisted in :

glass reinforced vinyl ester resin composites with a gelcoat surface finishing

→ Composite material

Introduction

Complex interaction between the sea water component and properties and the degradation of the composite material in immersion

- **Water absorption:**
 - Lead to plasticization → diminution of the glass temperature transition, loss of mechanical properties
 - Matrix swelling → create interfacial cracks and fiber/matrix debonding
- **Mechanical load:**
 - the general effect of mechanical loading onto the composite material is to **enhance the moisture-penetration** mechanisms **producing higher rates and maximum levels of moisture penetration**
- **UV degradation:**
 - **Modification of the chemistry** → rupture of chemical bond, synergy with water: hydrolysis
- **Fouling interaction:**
 - Growth of biofouling on the material → degradation of the material due to the metabolism of the micro and macro-organisms.

Ageing → interaction with sea water (natural or artificial)

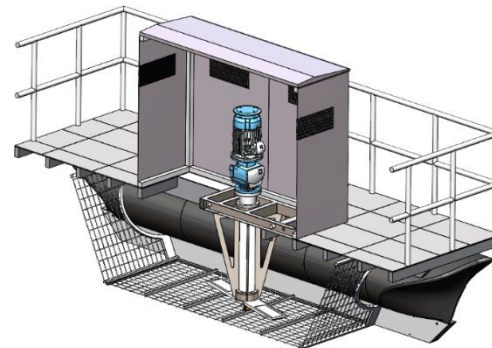
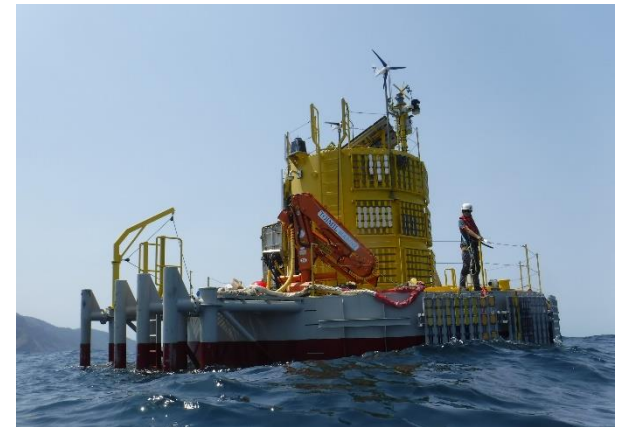
New ageing procedure

2 parallels lines:

- **Natural ageing:**
 - Port of Pasaia (Tecnalia facility)
 - Harshlab (Tecnalia facility)
 - Dynamic fouling test system (DCU facility)
- **Artificial ageing:**
 - Accelerated ageing in laboratory (Tecnalia facility)
 - Tailored accelerated wear test (SSPA facility)

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Samples exposed in immersion (1m deep under the lowest surface point) for 10 months with 2 intermediate inspections.

Samples exposed along the length of the blades → change of hydrodynamic conditions
Samples exposed up to 24 weeks with intermediate inspection

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New ageing procedure

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 - Accelerated ageing in laboratory (Tecnalia facility)



	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Aging media	Condensation 24h	Condensation 24h	Immersion seawater 24h	Immersion seawater 24h	Immersion seawater 24h	Immersion seawater 24h	Immersion seawater 24h
Temp.	T=50°C	T=50°C	T=30 °C	T=30 °C	T=30 °C	T=30 °C	T=-2 °C
Radiation	12h UVA 340, 0,68 W/m2 12 h OFF	12h UVA 340, 0,68 W/m2 12 h OFF					



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Temp.	T=30 °C	T=30 °C	T=30 °C	T=30 °C	T=30 °C	T=30 °C	T=-2 °C

UV are not relevant

- Tailored accelerated wear test (SSPA facility)



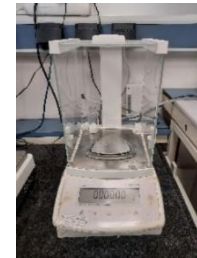
**Characterization → assessment
of the damages due to ageing**

Characterization

- Interaction sea water / composite material:

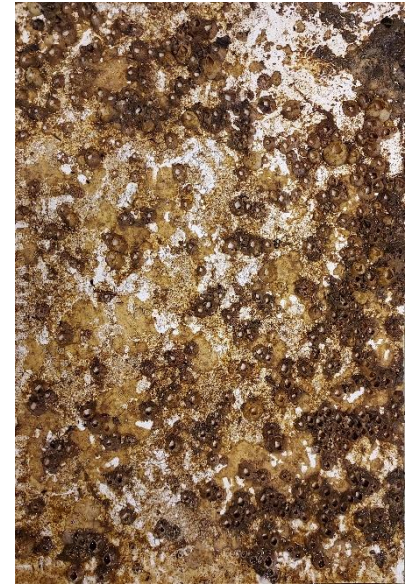
For samples aged in Pasaia, Harshlab and Tecnalia laboratory:

- Gravimetry (water uptake)
- FTIR (evolution of the surface chemistry) → confirmation no effect of UV)
- DSC (plasticization/ change of Tg)
- Tensile test: effect on the mechanical properties



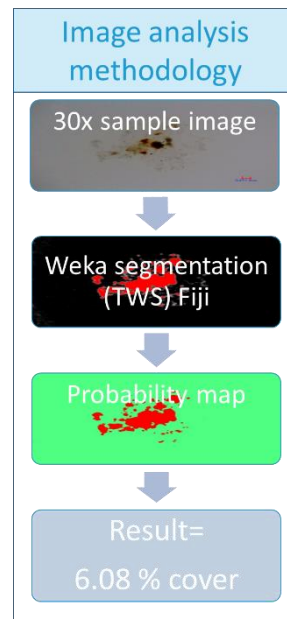
Characterization

- Image analysis (all the test)
- In the case of fouling growth (Natura ageing in Tecnia and DCU)

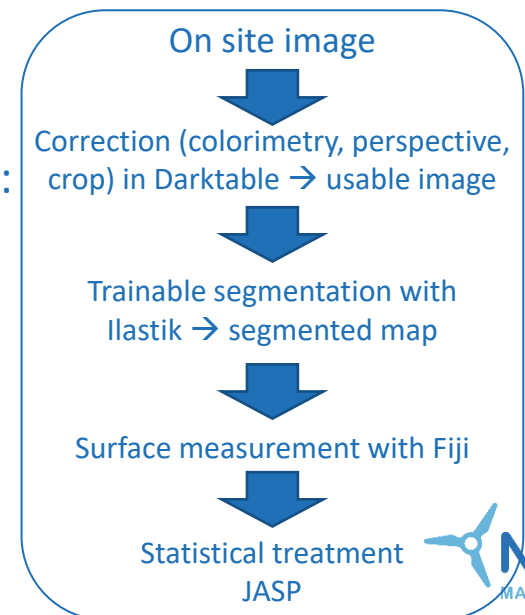


→ Use of machine learning based technique to perform the image analysis

Procedure
in DCU:



Procedure
in Tecnia:



Conclusion

Conclusion

To assess the complex interaction between the sea water and the composite material, new procedure were developed :

- Use of new ageing infrastructure such as Harshlab or specifically design within the project as the DCU facility.
- New accelerated ageing test procedure based on coating testing
- Use of novel technology such as machine learning for image processing to assess the fouling coverage

Thank you for your attention!

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