

# Thermo-oxidation of organic matrix composites for aircraft applications

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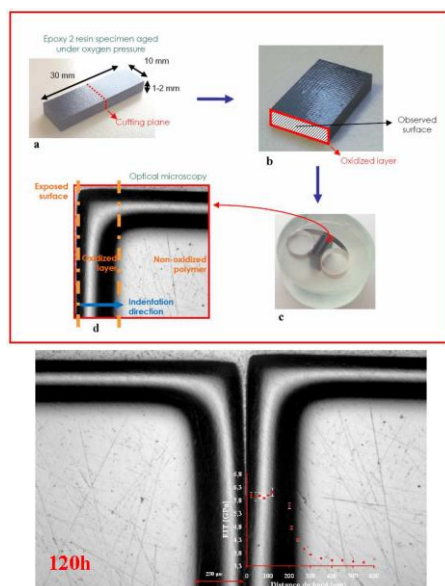
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**Research programs:** ANR IMPEKKABLE (2015-2019), PRC Composites (2011-2014), FUI COMPTINN' (2010-2013), ANR COMEDI (2005-2008), RRIT SUPERSONIQUE (2000-2004)

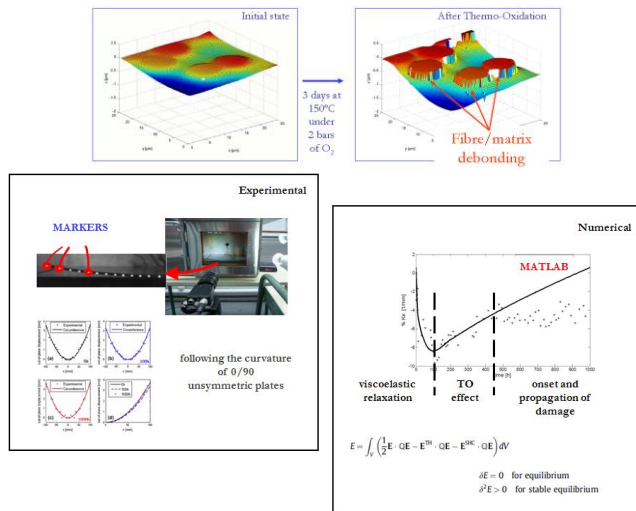
**Experimental tools:** Ultra-micro indentation, Interferometric microscopy, SEM, X-ray micro-tomography, house experimental devices for mechanical testing under controlled environment (temperature, neutral or oxidative)

**Context:** The aim of this operation is to characterise the effect of thermo-oxidation on the behaviour (constitutive law, damage onset and propagation) of organic matrix composites for aircraft applications, in view of building predictive models, which can be useful for design and optimisation of structures. This aim is carried out by building and developing specific experimental test (coupled, uncoupled, multi-scale ...) and by interpreting them by the aid of dedicated multi-physical/multi-scale models based on the Thermodynamics of Irreversible Processes. The models are implemented into commercial finite element software (such as, for instance, ABAQUS) or solved by dedicated numerical methods/schemes, such as the Proper Generalised Decomposition technique.

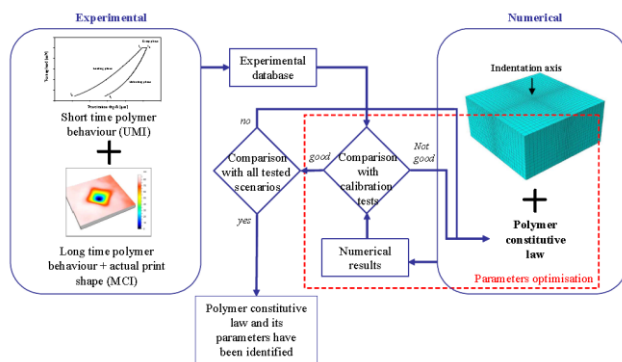


## Characterisation of the effects of thermo-oxidation on the mechanical behaviour of OMC

- ✓ Coupled approach employing ultra-micro indentation and confocal interferometric microscopy for the characterisation of the local constitutive law of virgin and aged resin samples
- ✓ Confocal interferometric microscopy observation of thermo-oxidation induced matrix shrinkage and damage onset in composites at the microscopic scale

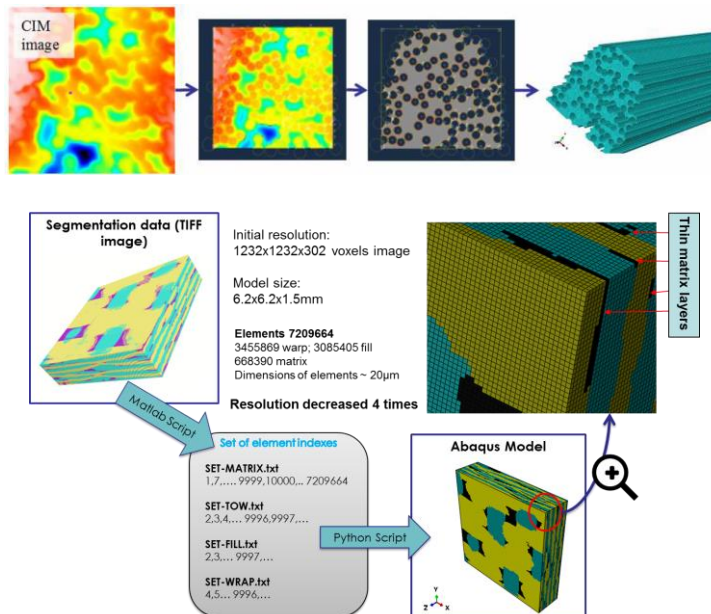


- ✓ Traction tests on model [0/90]s virgin and aged samples
- ✓ Employment of model [0/90] unsymmetrical samples for on-line monitoring of thermo-oxidation in composite laminates
- ✓ Multi-physical fatigue at high temperature and under oxidizing environment (air, O<sub>2</sub>) on laminated and textile composites



## Modelling thermo-oxidation and its effects on the mechanical behaviour of OMC

- ✓ Employment of Thermodynamics of Irreversible Processes for the development of coupled multi-physics models
- ✓ Development of dedicated subroutines (UMAT/UEL) in the commercial finite element software ABAQUS for the simulation of thermo-oxidation in composites
- ✓ Development of reduced order methods (Proper Generalised Decomposition method) for simulation and identification of multi-physics couplings
- ✓ Development of FE models starting from micro-tomographic images: segmentation, meshing, analysis



## Publications:

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