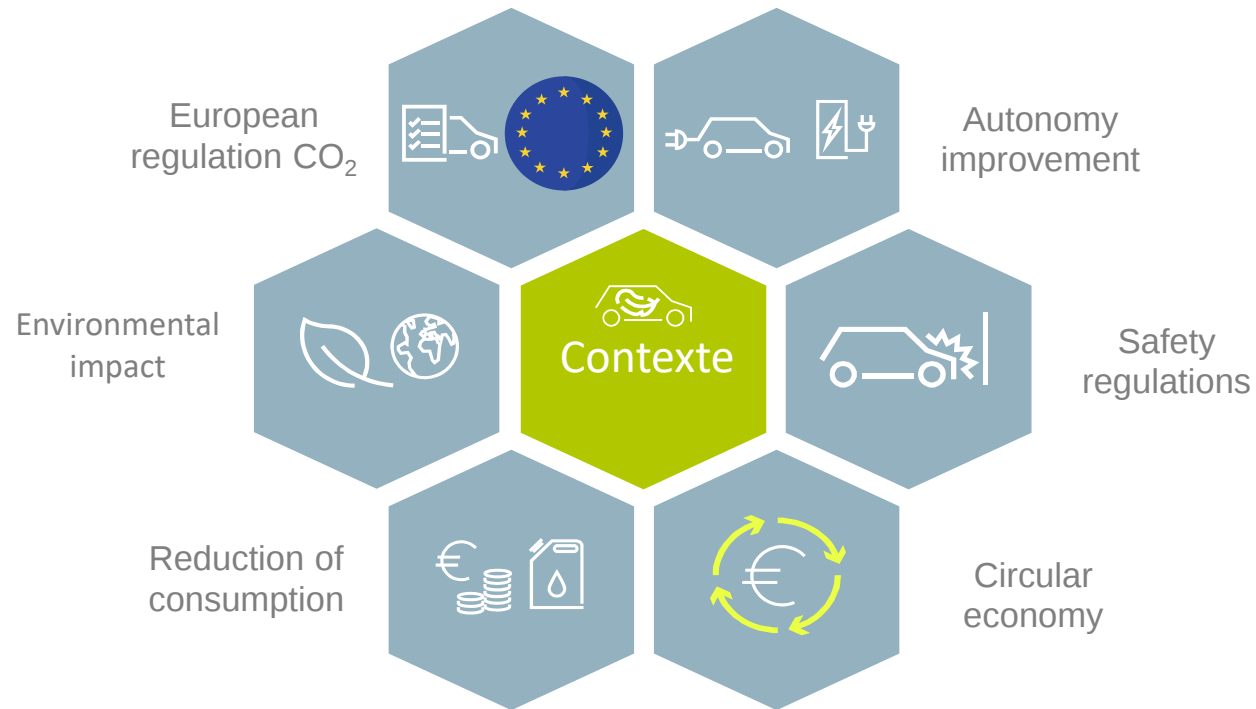


**TWENTY-THIRD INTERNATIONAL CONFERENCE
ON COMPOSITE MATERIALS (ICCM23)**



**Elaboration of hybrid bio-composites with
thermoplastic matrix: material formulation and
modelling of the quasi-static behaviour**

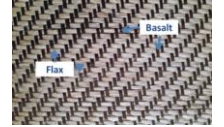
Supervisors Prof. Patrick ROZYCKI & Prof. Christophe BINETRUY
PhD student Wassim GUERFALA



Objectives

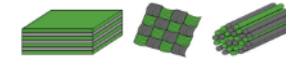
- Integration of bio-composite materials in the automotive structure
- Material designing

Biomaterials



- Unique combination of natural materials

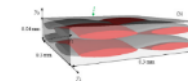
- Flax : Plant fibre
- Basalt: Mineral fibre from volcanic rock.
- PA11 : bio-sourced thermoplastic matrix



Hybridisation

- Synergy creation between two types of fibres for different scales

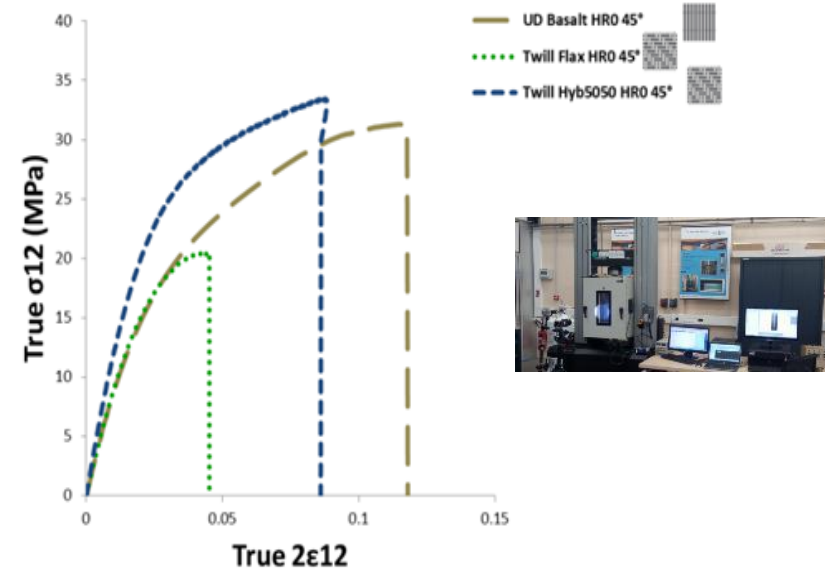
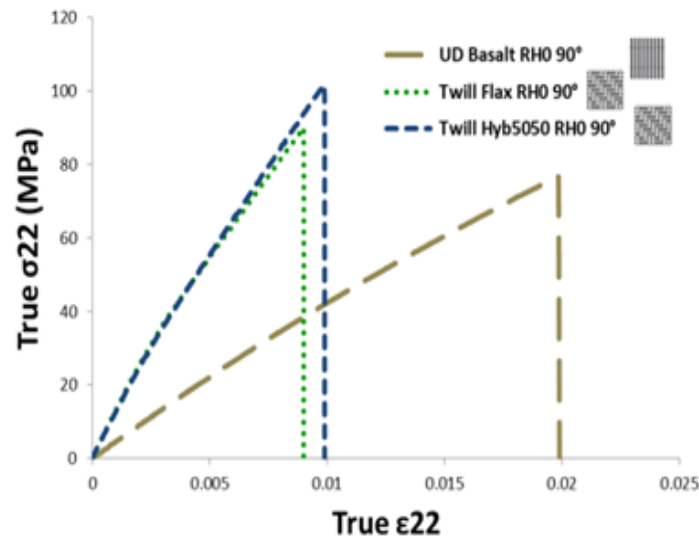
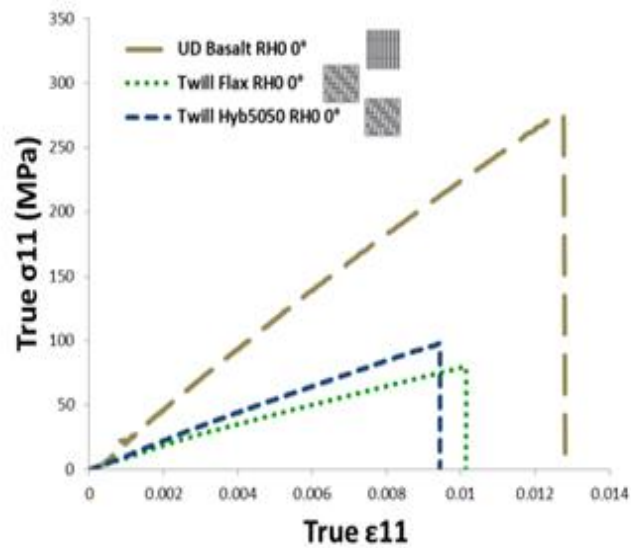
- Laminate scale: Basalt layer / flax layer
- Fabric scale: co-weaving : fibre hybridisation (Flax+ Basalt)
- Fibre scale: commingling of two different fibres



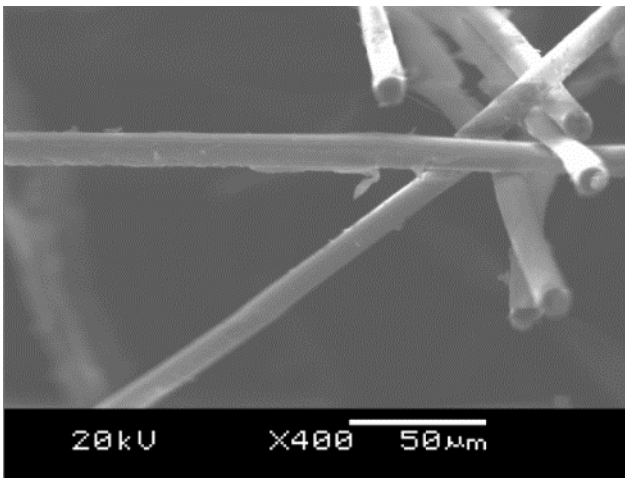
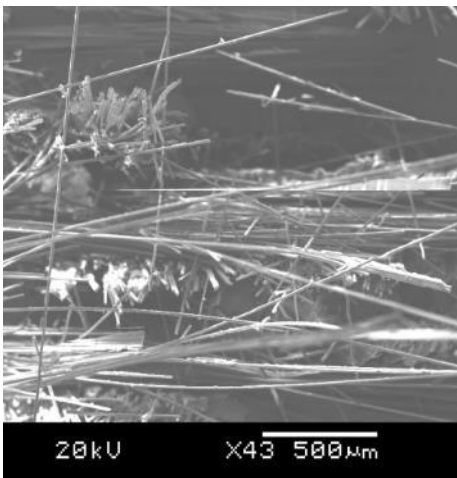
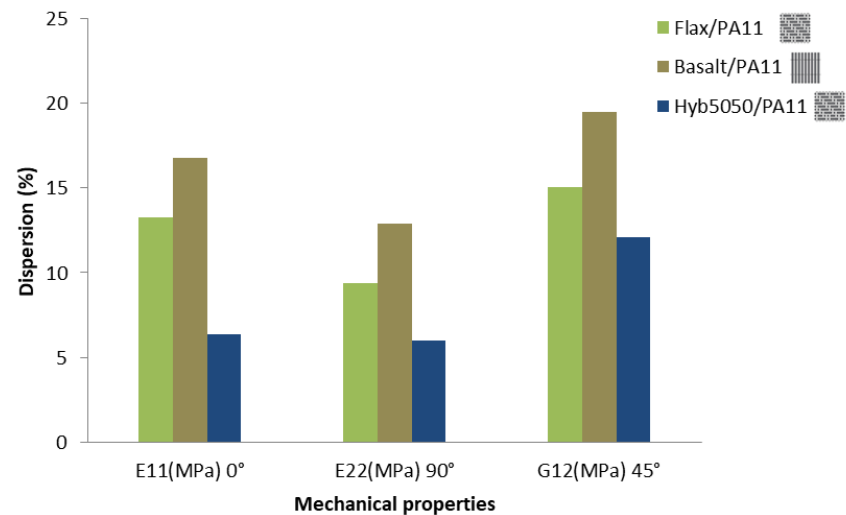
Numerical tool

- Prediction of the mechanical behaviour of all types of composite material combinations

- Optimization of the fibers choice according to the final application (mechanical performance, cost, etc.).

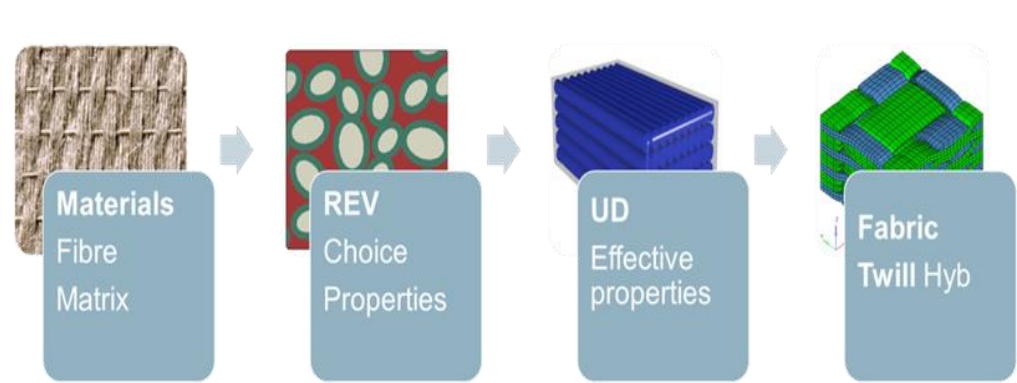


$\sigma_{true} = f(\epsilon_{true})$ for the flax/PA11, Hyb5050/PA11 & basalt/PA11 composites for RH0 and 0°, 45° and 90° at 23°C

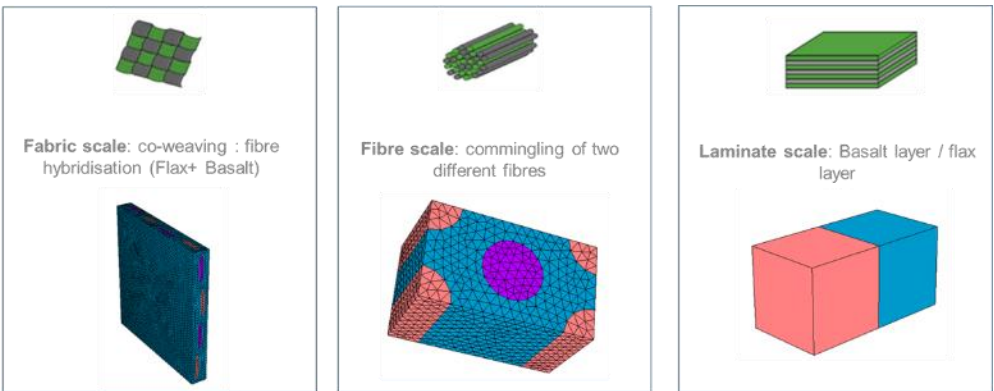


Mechanical property dispersion for basalt/PA11, flax/PA11 and hybrid5050/PA11 composites for directions 0° 45° and 90°.

Microscopic study SEM Flax x43 /x 400



Multi-scale Homogenization protocol for the hybrid composite

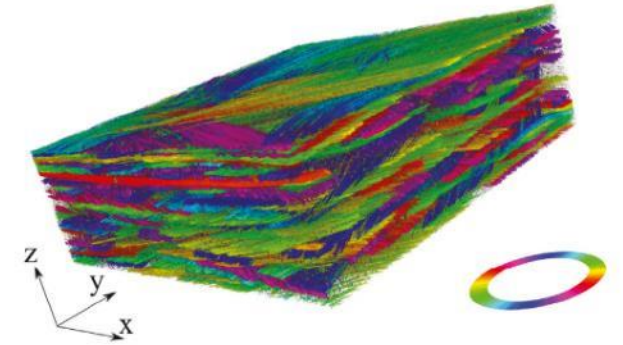


REV developed on Hypermesh for the different scales of hybridization

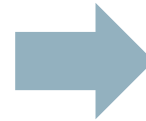
Composite Materials	Relative Humidity	E11(MPa)	E22(MPa)	G12(MPa)
Flax/PA11	HR0	9970	9970	1090
	HR50	9270	9250	923
	HR85	8550	8554	817
Basalt/PA11	HR0	27700	2330	1040
	HR50	24900	1800	804
	HR85	24800	1570	702
Hybride5050/PA11	HR0	15000	15000	1090
	HR50	14100	14100	893
	HR85	13400	13400	782
Hybride3070/PA11	HR0	13900	13900	1080
	HR50	13000	13000	889
	HR85	12700	12184	778

Comparative table of numerical mechanical properties of Flax/PA11, basalt/PA11, hyb5050/PA11 composites for RH0,RH50 and RH85

- Improvement of the hybrid composite stiffness
- Reduction of the hybrid composite moisture sensitivity
- Reduction of the flax mechanical characteristic's dispersion
- Hybrid composite density reduction



hybrid5050/PA11



Alpine car

- Aesthetic appearance of the composite part
- Reinforcement of the part by overmoulded ribs
- Use of PA11 matrix filled with short fibres (basalt + flax)

Thank you