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On the Numerical Modeling of Fiber-reinforced Composites: Towards Industrial Applications

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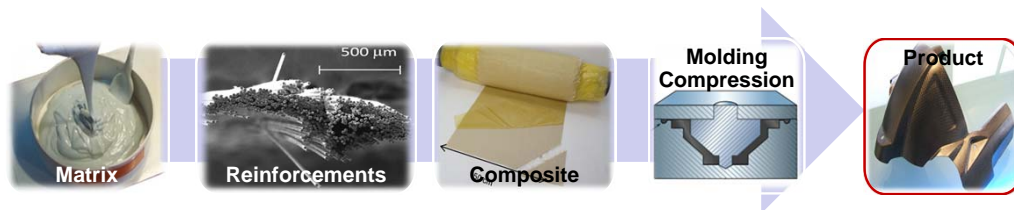
stakeholders



Process and Industrial Application

Fiber Reinforced Composites: SMC

- Motivation: Possible ways to reduce CO2 emission.
- Automotive: 10% weight reduction compared to all-aluminium design.
- Produce structural parts using fiber reinforced polymer composites: « Ultra Light » or « High Performance »
- SMC (Sheet Moulding Compound) process:
4 Steps: Flat pattern insertion, Filling, Curing, Ejection.



Authors

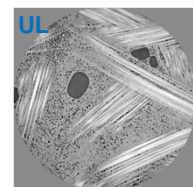
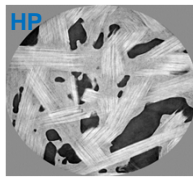
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Rheological Behaviour of SMC under Compression

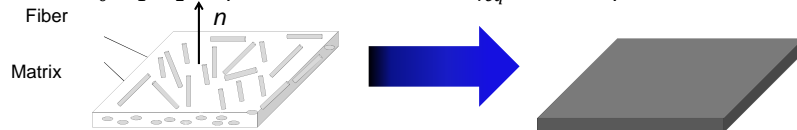


Micro-tomographies
before molding

- Homogenisation: fiber and matrix are seen as a single phase
- Model of planar isotropy: fiber orientation perpendicular to vector n
- Anisotropic compressible Stokes equations coupled with thermo-kinetic equations [Dumont *et al.*, 2003],[Boyer *et al.*, 2007]
- Viscous stress Tensor: $\underline{\underline{\sigma}} =$

$$\alpha_0 \eta_{eq} \left[\underline{\underline{D}} + \alpha_1 \left(\underline{\underline{M}} : \underline{\underline{D}} \right) \cdot \underline{\underline{M}} + \frac{1}{2} \alpha_2 \left(\underline{\underline{M}} \cdot \underline{\underline{D}} + \underline{\underline{D}} \cdot \underline{\underline{M}} \right) \right],$$

- $\alpha_0, \alpha_1, \alpha_2$, depend on fiber fraction, η_{eq} follows a power law, $M = n \otimes n$



Numerical Simulations

Finite Element Library fully parallelized

- Immersed methods and mesh adaptation.
- Interface tracking and mass conservation.
- Friction against wall, Penalty method for Boundary Conditions.

