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

Rheological Behaviour of SMC under Compression

- 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: $\sigma = \alpha_0 \eta_{eq} \left[ D + \alpha_1 \left( M^{T} D \right) M + \frac{1}{2} \alpha_2 \left( M^{T} D + D^{T} M \right) \right]$
- $\alpha_0, \alpha_1, \alpha_2$ depend on fiber fraction, $\eta_{eq}$ 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.