Multiscale modeling and simulation of polymer flow

Roland KEUNINGS, Université Catholique de Louvain, Belgium

- **Rheology and Non-Newtonian fluid mechanics**
  - Non-Newtonian behaviour: phenomenology
  - Viscoelastic effects in complex flows
  - Illustrations: polymer melts and solutions

- **Multiscale modeling**
  - Memory and structure
  - Macroscopic conservation equations
  - Kinetic theory description: the Fokker-Planck equation
  - Stress-configuration relation
  - Macroscopic constitutive equations and closure approximations
  - Illustrations: dumbbell and tube models

- **Computational techniques and simulation of complex flows**
  - Spectrum of available approaches
  - Numerical challenges
  - Macroscopic techniques
  - Micro-Macro techniques
  - Simulation of complex flows: a few examples

Complex flows of micro/nano structured fluids: Reinforced polymer composites

Francisco CHINESTA, ESI & EADS Chair, Ecole Centrale de Nantes, France

- **Rheology of short fiber suspensions**
  - Microscopic description: the Jeffery's equation
  - Kinetic theory description: the Fokker-Planck equation
  - Macroscopic description: moments-based descriptions & closure relations
  - From dilute to semi-dilute regimes: rods interactions
  - From semi-concentrated to concentrated regimes: aggregation
  - Multi-scale description of rods clusters
  - On the numerical modeling:
    - Flow solvers: mesh versus meshless
    - Particles-based techniques
    - Stochastic versus deterministic solution of the Fokker-Planck equation
    - Advanced solvers: the Proper Generalized Decomposition

- **Processing**
  - 3D flows
  - Squeeze flows
  - Injection processes
  - Extrusion processes

- **Advanced topics**
  - Descriptions based on higher order kinematics
  - Introducing elasticity effects
  - Accounting for rods bending
  - Delaying orientation mechanisms: ad-hoc techniques and fractional mechanics
  - Non Newtonian solvents
  - Long fibers: the TIF model
  - Linear and nonlinear homogenization
  - Modeling electrical conductivity from a multi-scale approach

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Flows of simple and complex fluids in microstructures: Reactive processing and novel composite materials

Christophe BINETRUY, FAURECIA Chair, Ecole Centrale de Nantes, France

- **Introduction**

- **Description of fibrous microstructures**
  - Examples of polymer composites
  - Monodisperse porosity medium
  - Bidisperse porosity medium

- **Governing equations for flows in porous media**
  - Pore-scale description
  - Macroscopic scale : upscaling

- **Flow of simple fluids in non deformable fibrous microstructures**
  - Negligible inertia
  - Fluid inertia
  - Saturation

- **Flow of complex fluids in non-deformable fibrous microstructures**
  - Slightly compressible fluids
  - Highly compressible fluids
  - Reactive fluids
  - Non-Newtonian fluids
  - Fluid with microscopic fillers

- **Flow of simple fluids in deformable consolidating fibrous microstructures**
  - Compression of saturated composites
  - Through-thickness flow in initially dry fibrous microstructures

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