

Materials Processing and Manufacturing: Novel Processes and Modeling

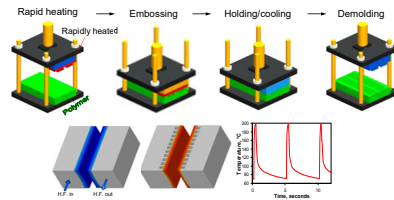
Contact: Prof. Donggang Yao; email: yao@gatech.edu
 School of Materials Science & Engineering
 Georgia Institute of Technology

Research Interest:

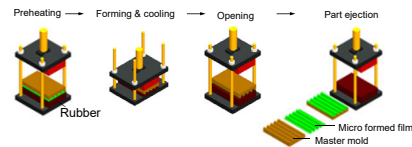
1. Development of new methods for precision polymer fabrication, blends processing, composites processing, gel spinning of ultrastrong fibers, and processing of bulk metallic glasses.
2. Constitutive modeling: rheology of immiscible polymer blends, nonlinear viscoelasticity, and deformation at micro/nano scales.
3. Dynamics of materials processing: modeling of non-Newtonian flow, finite-strain deformation, and blend dynamics.
4. Computational materials science: molecular dynamics, finite element analysis, and multiscale simulation.

Selected Processes:

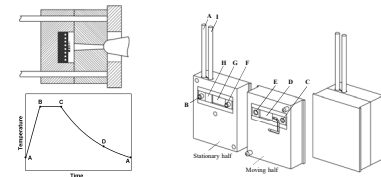
- Two-station embossing



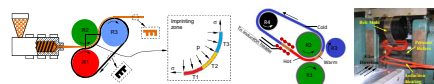
- Rubber-assisted micro forming



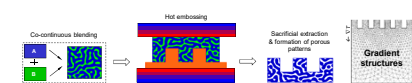
- Rapid-thermal-response micro injection molding



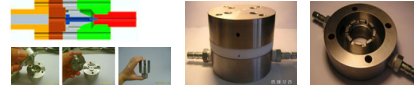
- Extrusion roll-to-roll micro/nano imprinting



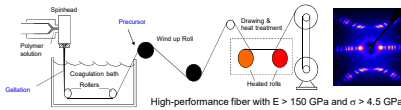
- Micropatterning of porous structures



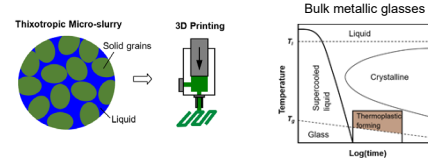
- Novel extrusion and fiber spinning processes



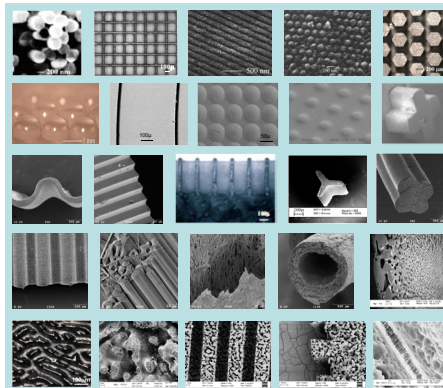
- Gel spinning of ultra-strong fibers



- Plastic processing of metallic alloys



Selected Parts/Structures:



Constitutive Modeling:

- Nonlinear viscoelasticity with a microstructure tensor

Non-oriented Deformed Oriented phase structure Non-oriented Deformed

$$U(F) = \int_{V_0} \int_{S_0} \sqrt{C}^{-1} : (m \otimes m) da'$$

$$T = f \left(A I + 2 \frac{\partial A}{\partial B} B \right)$$

$$T = \frac{2\theta}{3V} I + \frac{1}{V} \int_{V_0} \left(\frac{1}{3} m \otimes m \right) da'$$

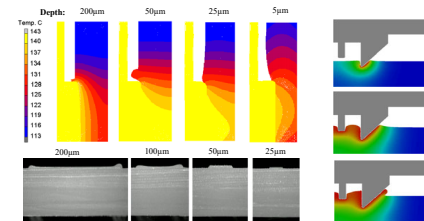
$$\frac{\partial}{\partial B} = \frac{1}{A_0(1-S/S_0)} B - \ln B$$

$$T = -pI + G_0(1-S/S_0)^2 B$$

Graph: Normalized Pressure vs. Time

Dynamics of Polymer Processing:

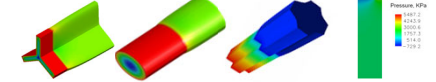
Nonisothermal embossing



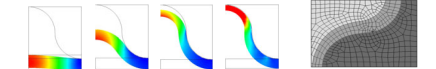
Noncircular fiber spinning



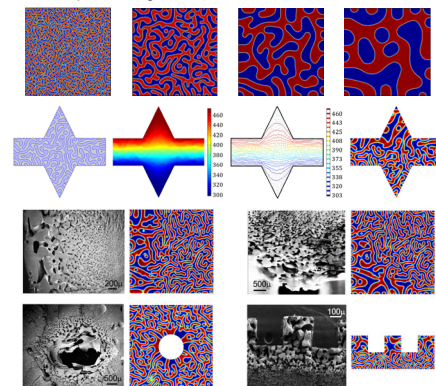
Extrusion



Micro-thermoforming



Blends processing



Acknowledgements

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