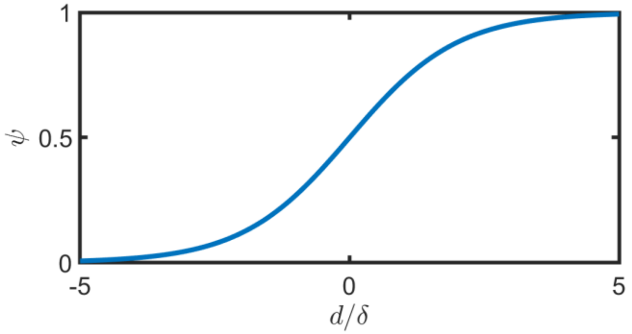
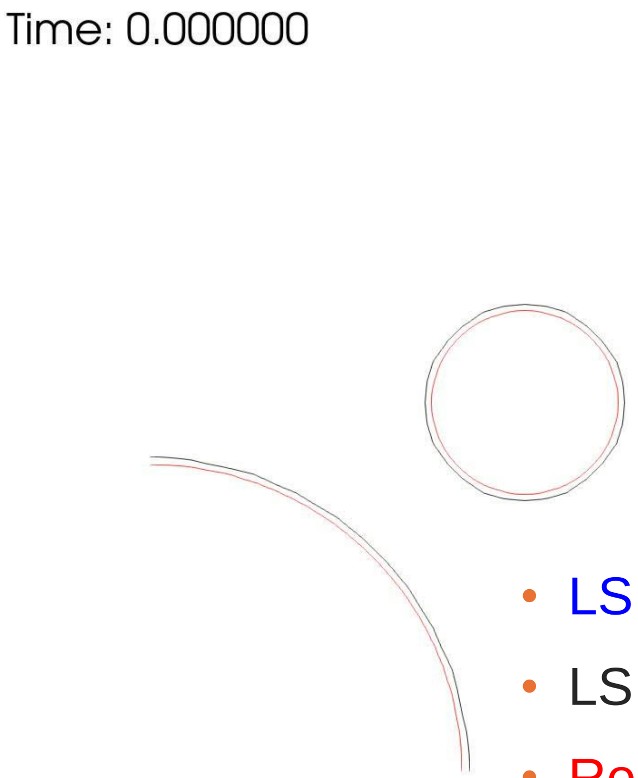
3D GP Simulation by Reduced-Order Models

- $$\frac{\partial \psi}{\partial t} + \overbrace{\mathbf{u} \cdot \nabla \psi}^{\text{convection}} = \overbrace{\gamma \nabla \cdot (\delta \nabla \psi + \psi(1-\psi)\mathbf{n})}^{\text{Reinitialization}}$$
- $\mathbf{u} = u_f \mathbf{n}, \ \mathbf{n} = -\nabla\psi / |\nabla\psi|$
- When $\mathbf{u} = 0$, converge to $\psi = \dfrac{1}{1+\exp(-d/\delta)}$
  - d: signed distance to an interface
  - δ: interface thickness
- LS model consumes $1/150$ resources than RD
  - A bit anisotropy with curvature model
- Future works
  - Free surface
  - Inverse problem



Front merging

- Initial radii: 15 mm & 4.5 mm
- Centers: (0, 0) & (18, 18) mm



- LS with uniform speed
- LS with curvature effect
- Reaction-Diffusion

Modeling by Reaction-Diffusion Equations

$$\text{Heat diffusion: } \frac{\partial T}{\partial t} = \overbrace{D\nabla^2 T}^{\text{Diffusion}} + \overbrace{\frac{H_r}{c_p}\frac{\partial \alpha}{\partial t}}^{\text{Source}}, \quad D = \frac{\lambda}{\rho c_p}$$

$$\text{Reaction: } \frac{\partial \alpha}{\partial t} = k(T)\, g(\alpha)$$

$$\text{ICs: } \alpha(t=0) = \alpha_0, \; T(t=0) = T_0$$

T: temperature

α: degree of cure

D: thermal diffusivity

λ: thermal conductivity

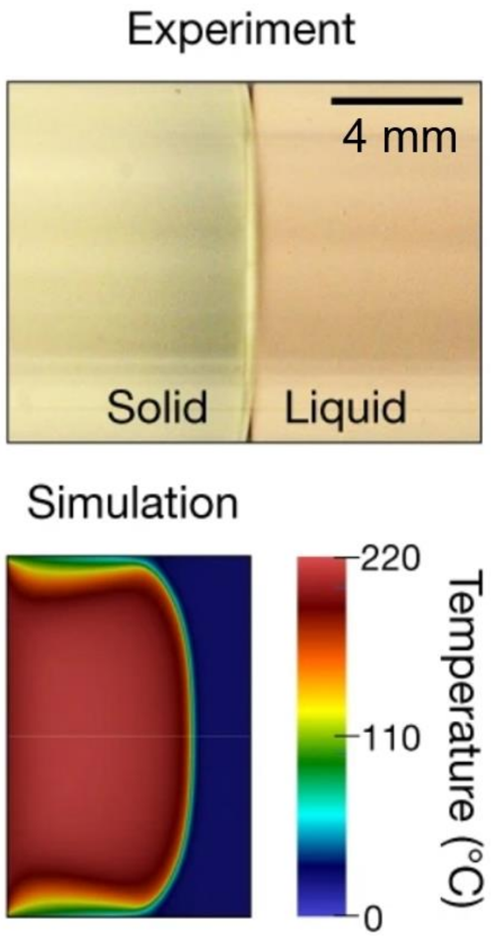
ρ: density

H_r: reaction enthalpy

c_p: specific heat

$k(T)$: reaction constant

$g(\alpha)$: cure kinetics model



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