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Analysis of Key Factors Controlling Sintering of Dense and Porous CGO Bi-layers

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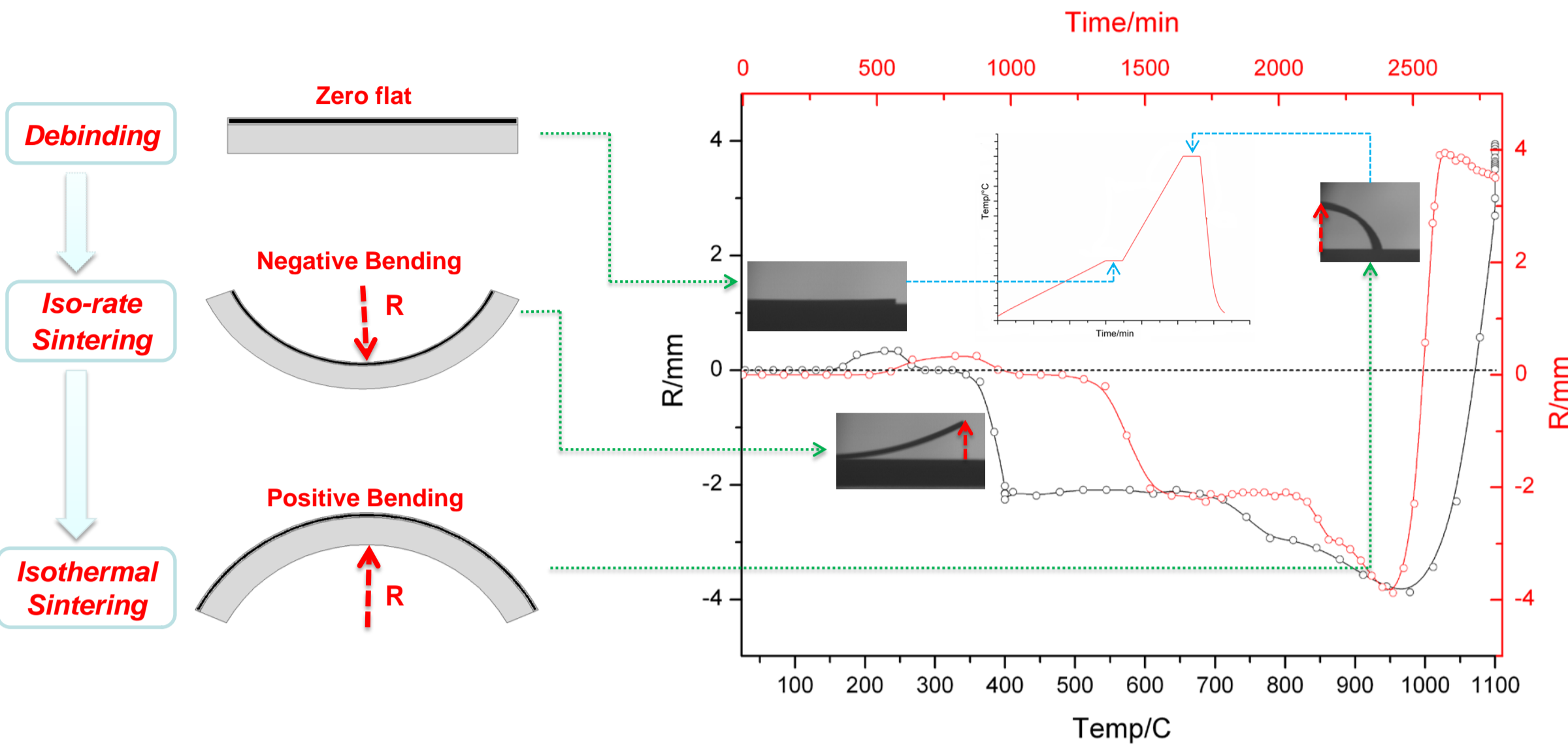
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Problem and Objective

- Difference in shrinkage rate often lead to shape distortion, warping or crack formation.
- Need for optimizing processing parameters to avoid such defects.



The aim is therefore to develop methods for predicting distortion and understand the shape stability during sintering of layered composites through modeling and experiments.

Model (Isothermal regime) - The kinetics of shrinkage and shape distortion

- Evolutions of porosity and thickness reduction in each layer

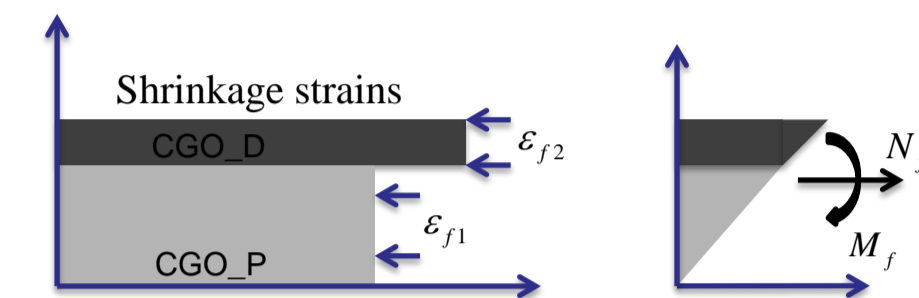
Model Features

Stress Developments

- Continuum theory of sintering : SOVS

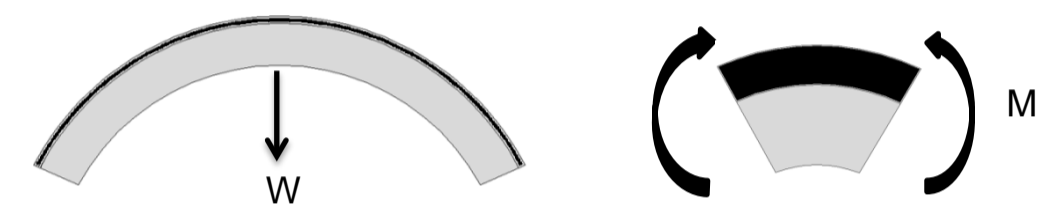
$$\sigma_{ij} = 2\eta_0 \left[\phi \dot{\epsilon}_{ij} + \left(\psi - \frac{1}{3} \phi \right) \dot{\epsilon} \delta_{ij} \right] + P_L \delta_{ij}$$

1. Differential shrinkage rate - biaxial stress



- Viscous analogy of classical laminate theories

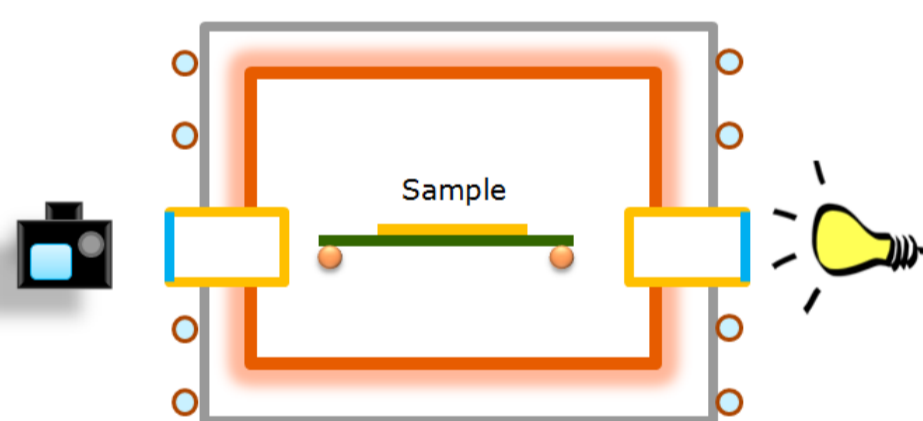
2. Creep due to own weight - uniaxial stress



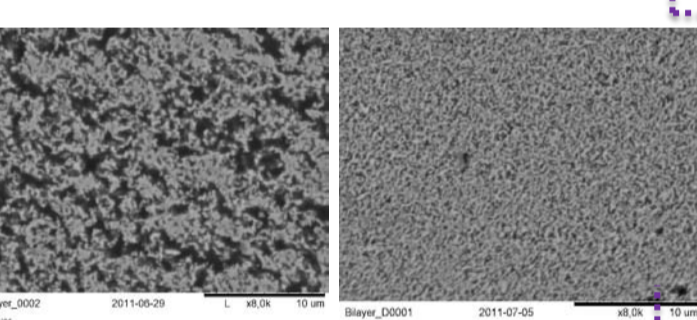
Experimental

Tape Casting + Lamination
Porous and dense layers of
CGO($Ce_{0.9}Gd_{0.1}O_{1.95-d}$)

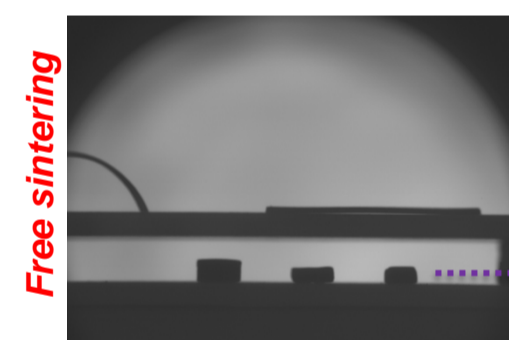
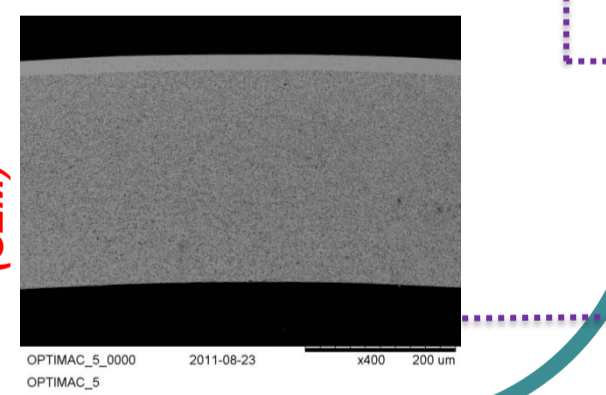
Pot-furnace



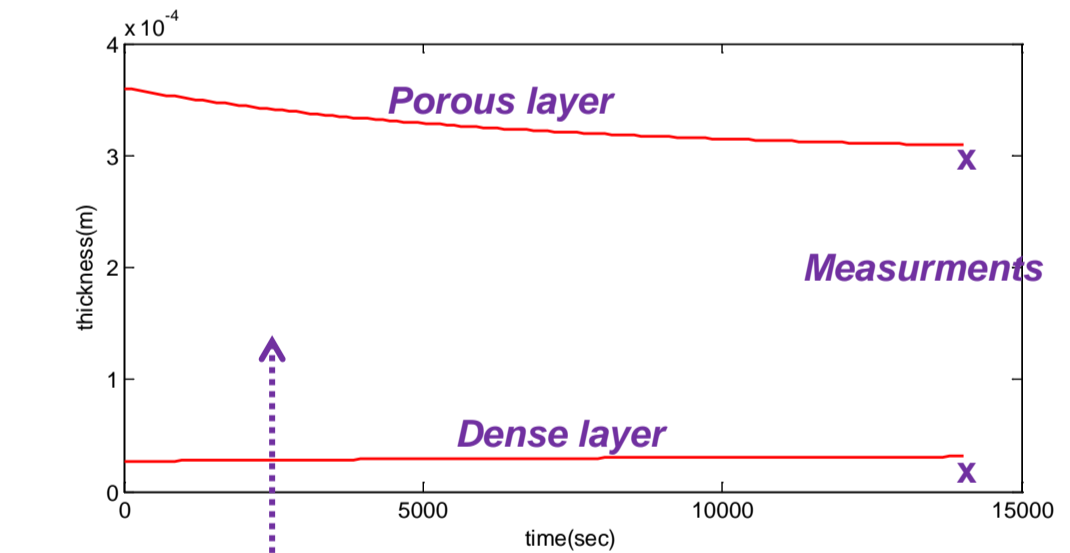
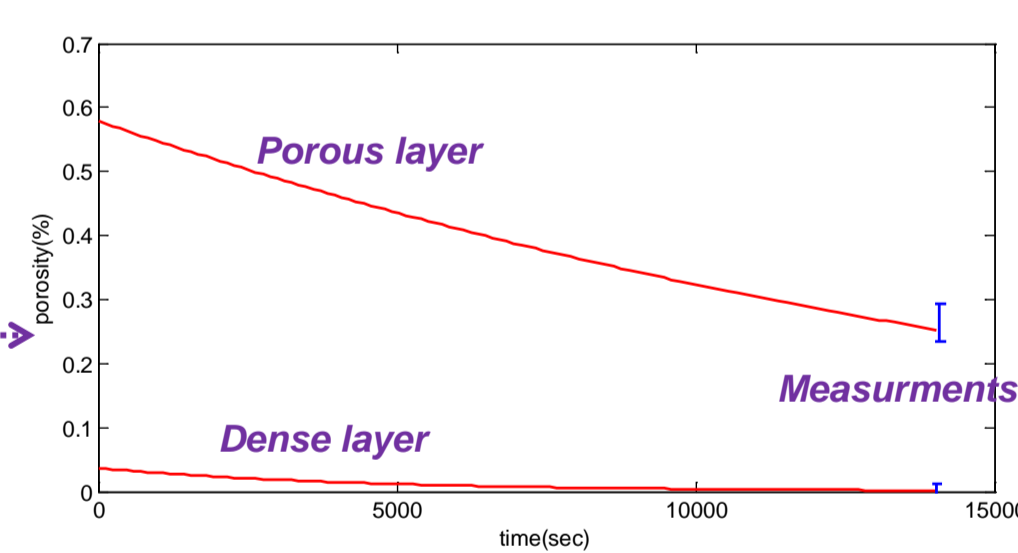
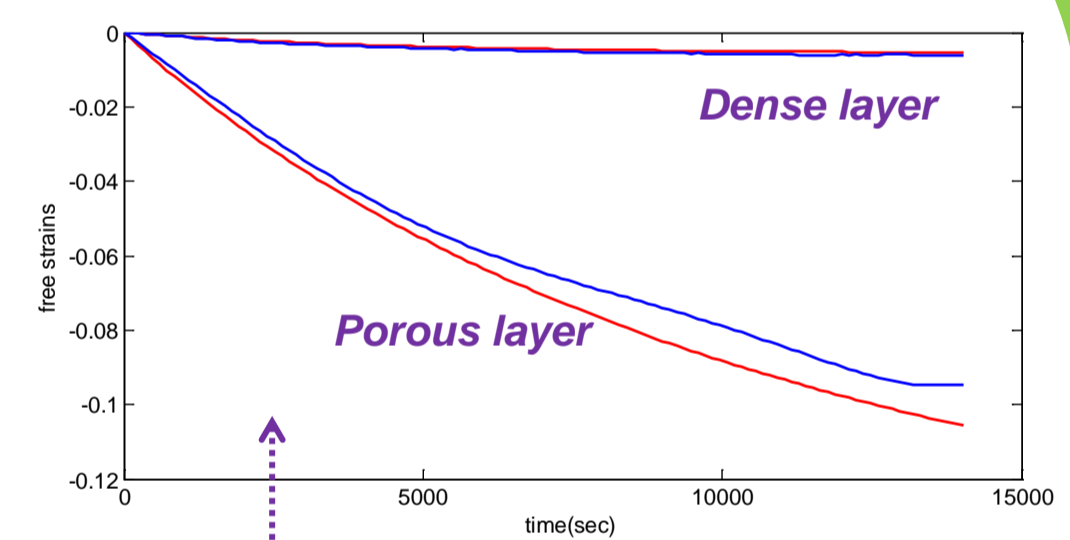
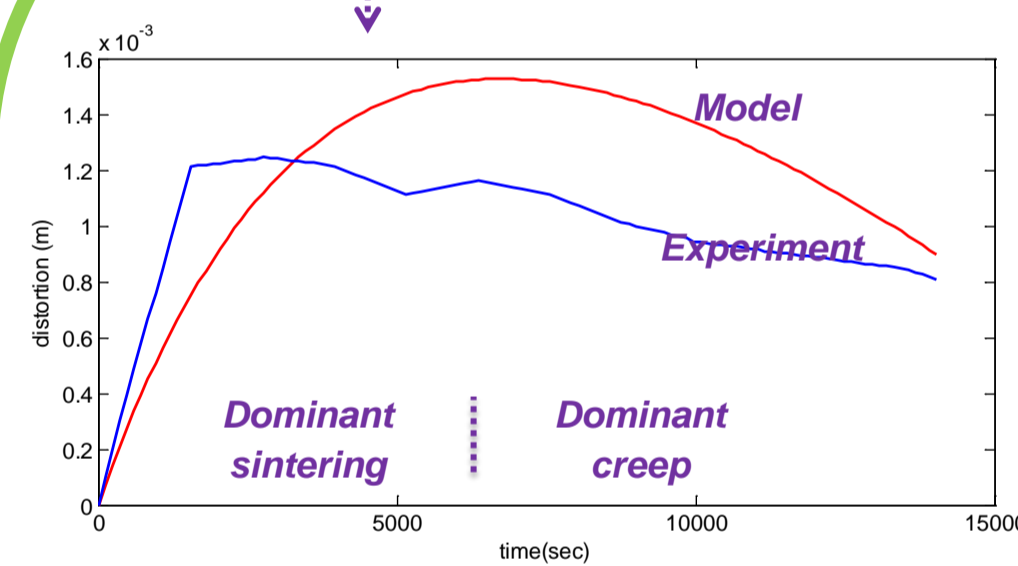
Porosity evolution (SEM)



Thickness reduction (SEM)



Results



Conclusions

- Shear viscosities and surface energies together with the average grain size of both layers are found to be the dominant factors controlling :
 - Distortion
 - Densification / porosity evolutions and Thickness reduction in each layer.

Acknowledgment

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- Initially rapid increment of distortion due to sintering followed by drop in curvature because of creep
- Rapid shrinkage in the porous layer
- Good agreements of model prediction and experiment in terms of porosity evolution and thickness reductions

Future work

- Improvement of the model prediction capability
- Addition of biaxial state of stress for creep
- Finite element simulation of same problems
- More experiments