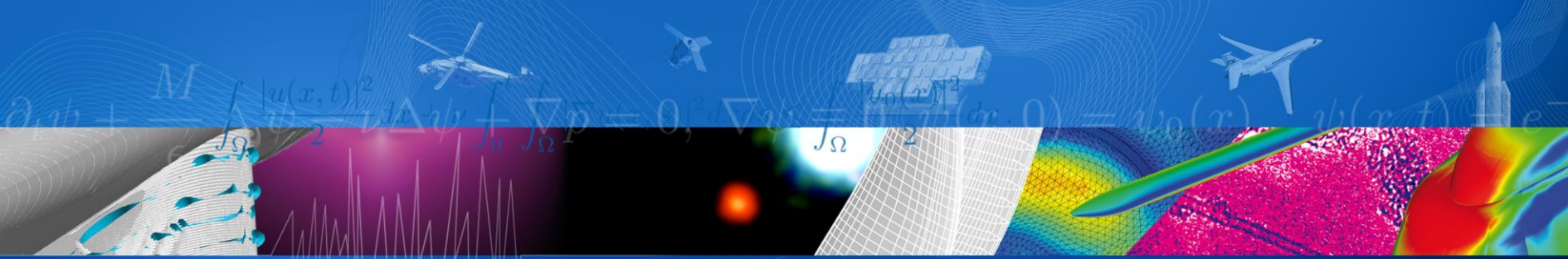

Melt Homogenization Improvement during the Bridgman Crystal Growth Optimizing the Rotation Profile

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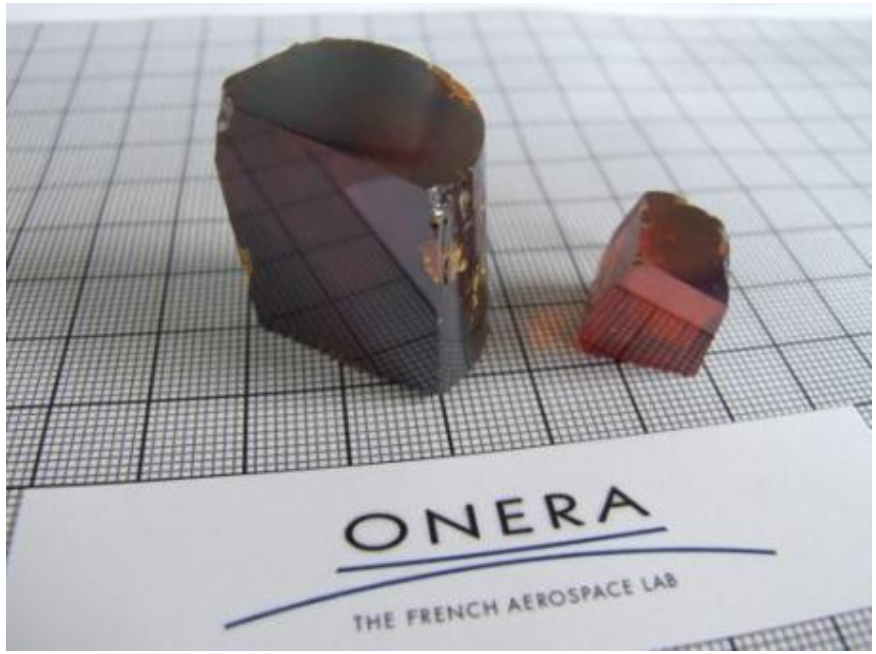
Outline

1. Context and Issues
2. Model
3. Results
4. Key observations
5. Perspectives



Mono-crystals of $AgGaGeS_4$ processed by Brdgman-Stockbarger furnace

Context and issues

- **Context:**

  - Synthesis of monocristals to non-linear laser applications in mid infrared

  - Need to be synthesized in close ampoule to prevent pollution by oxygen

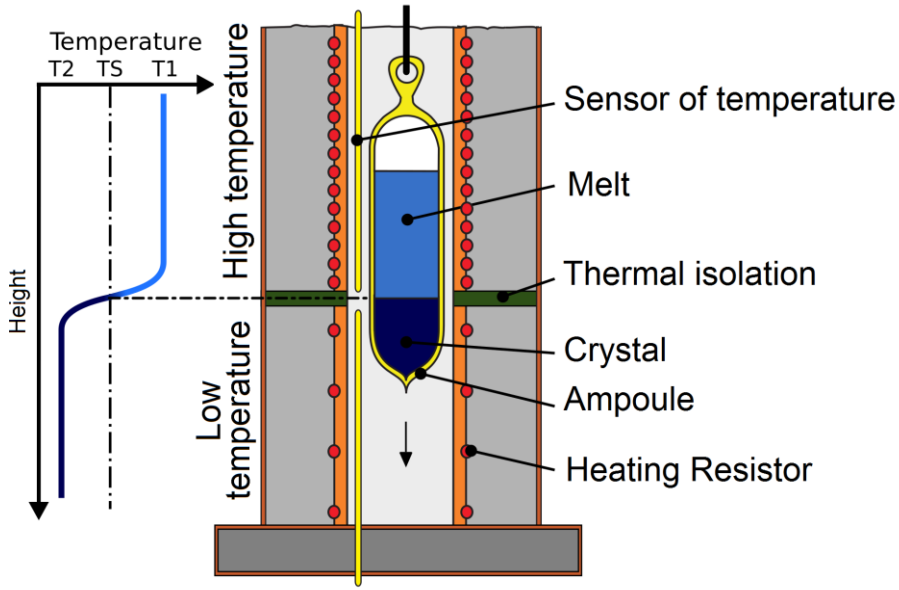
  - Synthesis in Bridgman-Stockarger furnace

- **Issue**

- Inhomogeneity can occur in the melt because of evaporation of chemicals or during crystallization

- Need to optimize the process to homogenize the melted compound

Easiest controled parameter to modify is the ampoule rotation



Scheme of Bridgman-Stockbarger furnace

Model

3 physical modules used:

- *Turbulent flow in low Re, k-ε*
- *Thermal convection with surface radiation*
- *Transport of diluted species*: to simulate the homogenization in the melt, an inhomogeneity of concentration was installed in a small volume in the ampoule

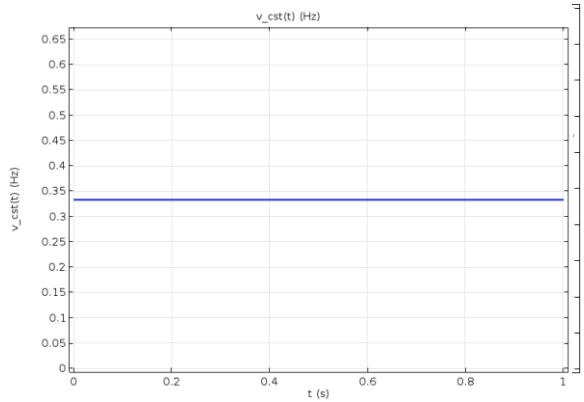
2 hypotheses: were used :

- Vertical movement is negligible

- Crystallisation of the phase change is not considered

2 profiles of speed usable:

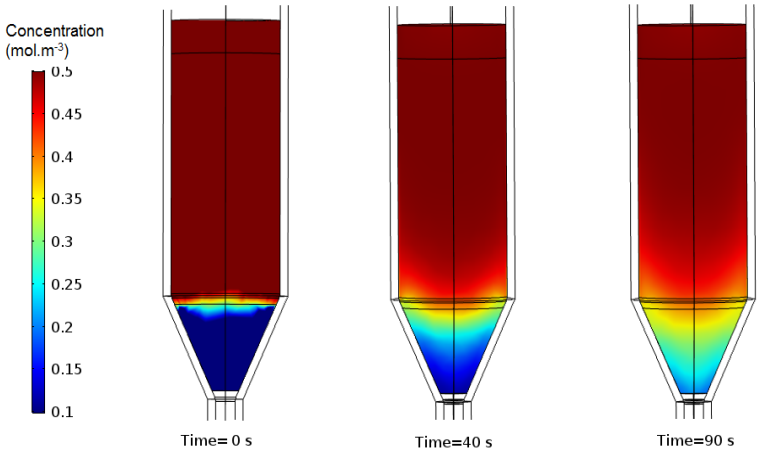
Constant rotation and variable rotation



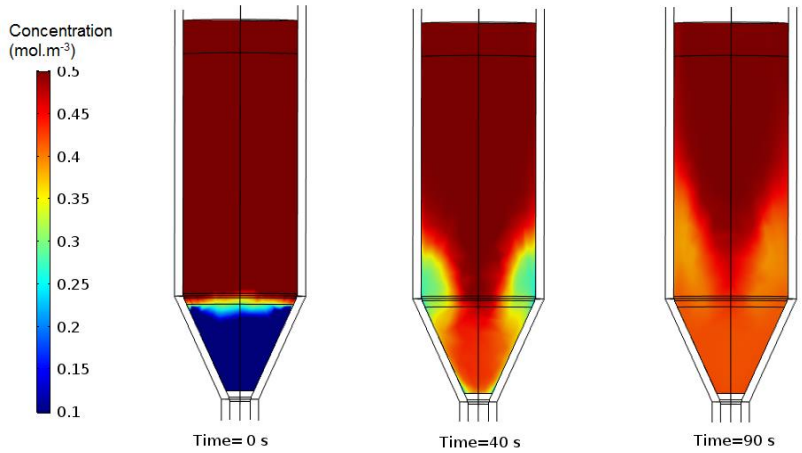
Speed profile of variable rotation

Results

Selection between constant rotation profile and variable rotation profile



Evolution of concentration for constant rotation (at 0s, 40s and 90s)



Evolution of concentration for variable rotation (at 0s, 40s and 90s)

-> Variable rotation seems better than constant rotation to homogenize the melt

Results

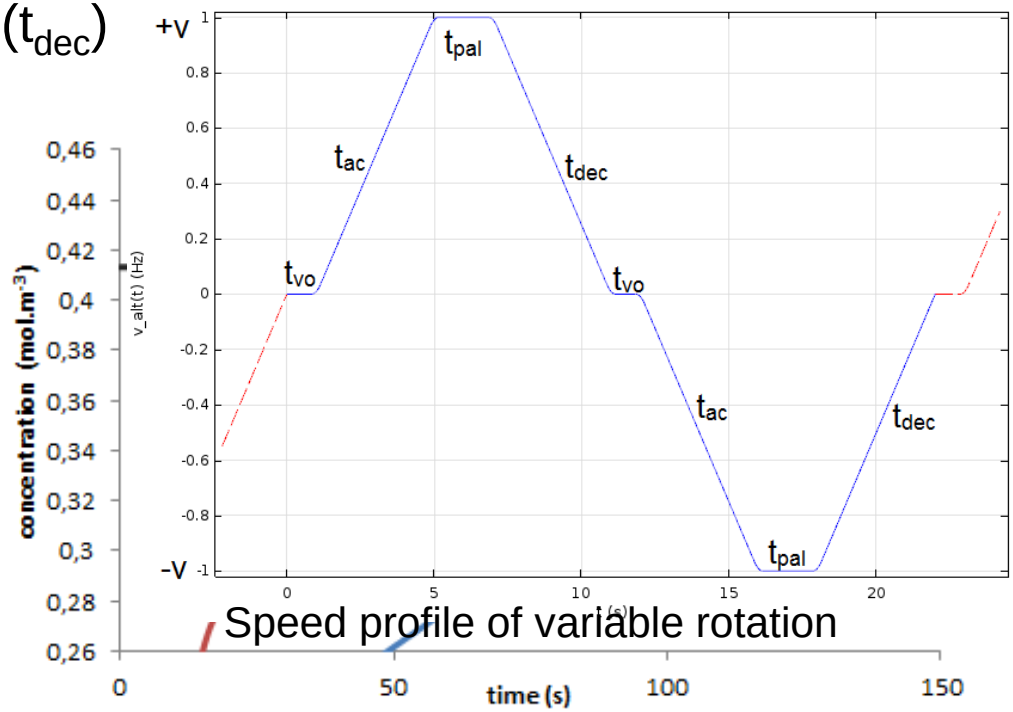
Optimization of the speed profile for variable rotation:

5 parameters can be modified for the optimization:

Max speed (v), Time at max speed (t_{pal}), Time at 0 rpm (t_{vo}), Acceleration time (t_{ac}) and Deceleration time (t_{dec})

Two steps:

- Study of the variation caused by the modification one one parameter
- Optimization of the profile using the precedent results



Speed profile of variable rotation

Time evolution of concentration for CR and optimized VR

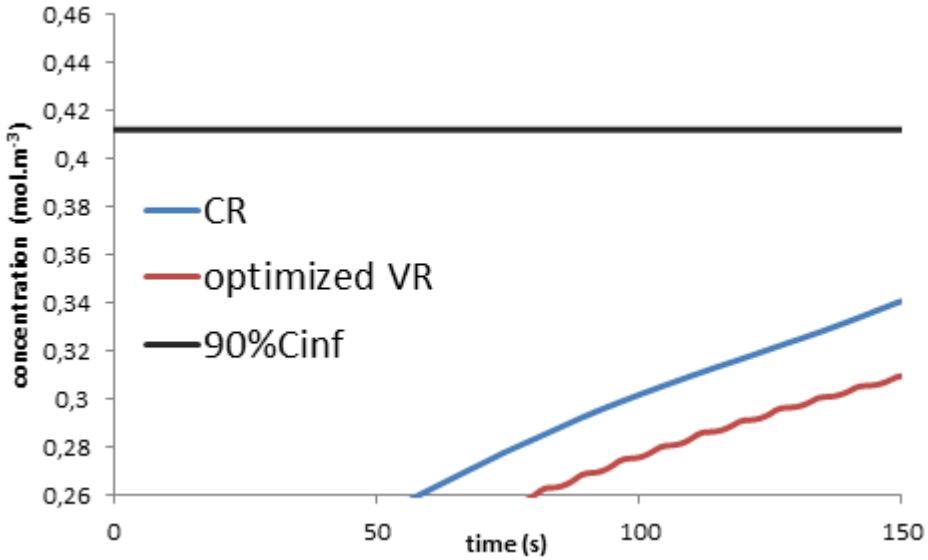
Results

Analyse when modifying the viscosity of the melt (μ=0,07mPa.s, 0,73mPa.s or 7mPa.s)

Viscosity of the melt is not know precisely -> Need to analyse the modifcation of viscosity

Modification of behaviour for highh visosity.

Tested Variable Rotation profiles get as worse as constant rotation.



Time evolution of concentration for CR and optimized VR (same profiles showed in the precedent slide)

Key observations

Variable rotation seems better to homogenize at low viscosity (μ<1mPa.s) in this geometry.

Good profiles were identified for low viscosity (μ<1mPa.s)

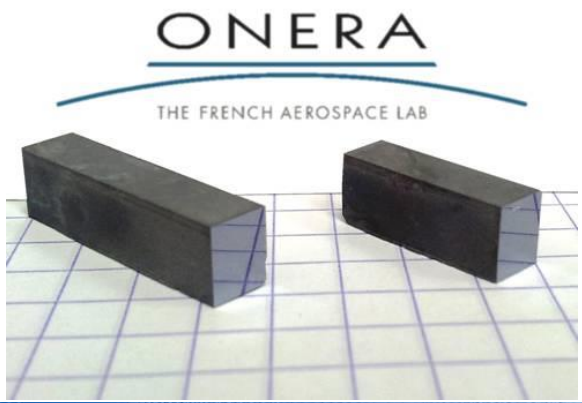
At higher viscosity, studied variable rotation profiles seem as worse as constant rotation.

Perspective

As the viscosity of our melted crystals are not known, optimization has to be done at high viscosity (μ≈7mPa.s)

Study of modification of the ampoule's geometry can be done.

The results of this study will be used to process our crystals



Two mono-crystal lingots of $ZnGeP_2$