

Drying step optimization to obtain large size transparent magnesium-aluminate spinel samples

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Introduction



Applications
Armor windows
Aerospace windows
missile IRdomes
High power lasers



- ⇒ Transparency in the visible & IR ranges
- ⇒ High mechanical resistance: toughness, hardness
 - sand, hail, bullet, birds,...
- ⇒ High temperature resistance:
 - Supersonic missiles
- ⇒ Chemical resistance
 - Rain erosion

Glass
complex shape processing
weak thermomechanical resistance

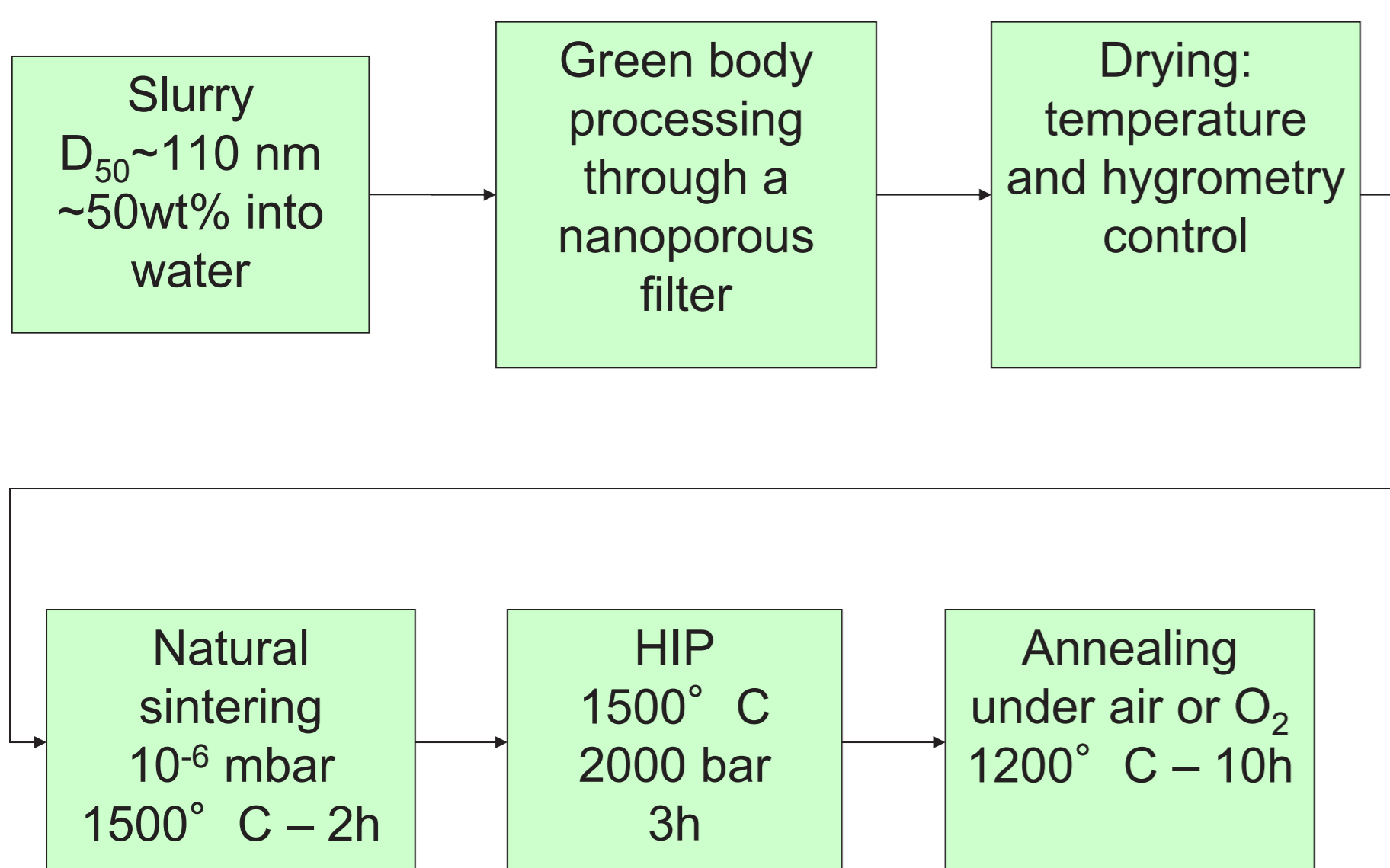
Single crystal
Difficult processing into complex shapes
High thermomechanical resistance

Transparent ceramics
complex shape processing
high thermomechanical resistance

↓

Spinel $MgAl_2O_4$
Optically isotropic
high thermomechanical resistance

General process

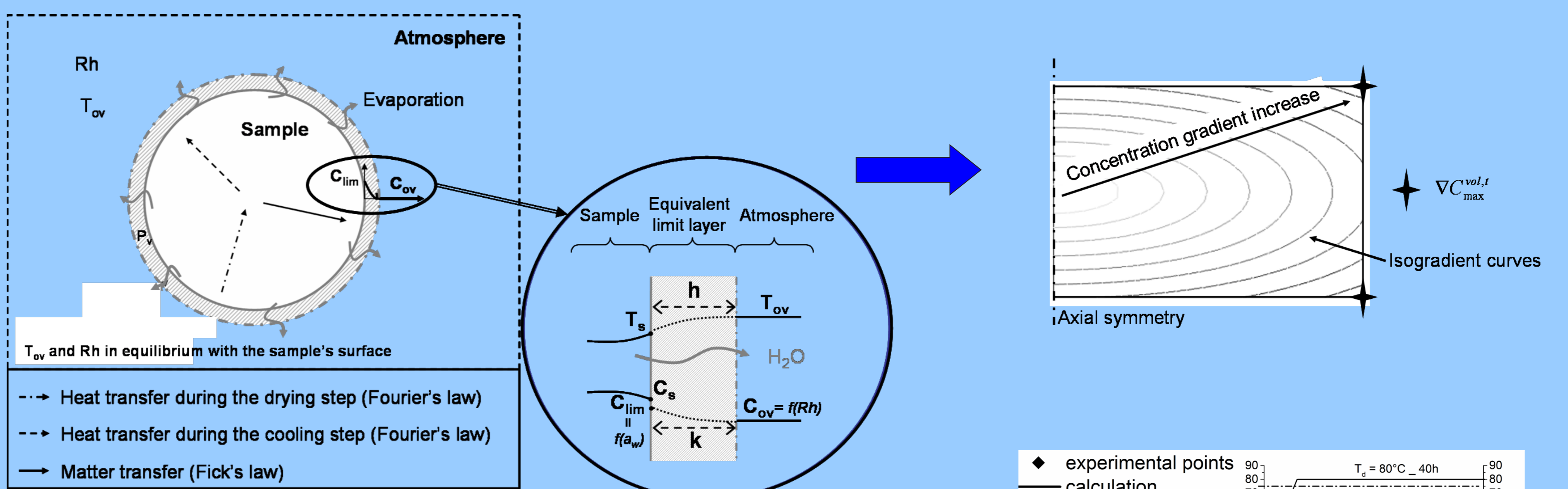


Drying optimization

Theory

Water concentration gradient ⇒ internal stresses ⇒ microcracks during drying ⇒ large cracks during sintering

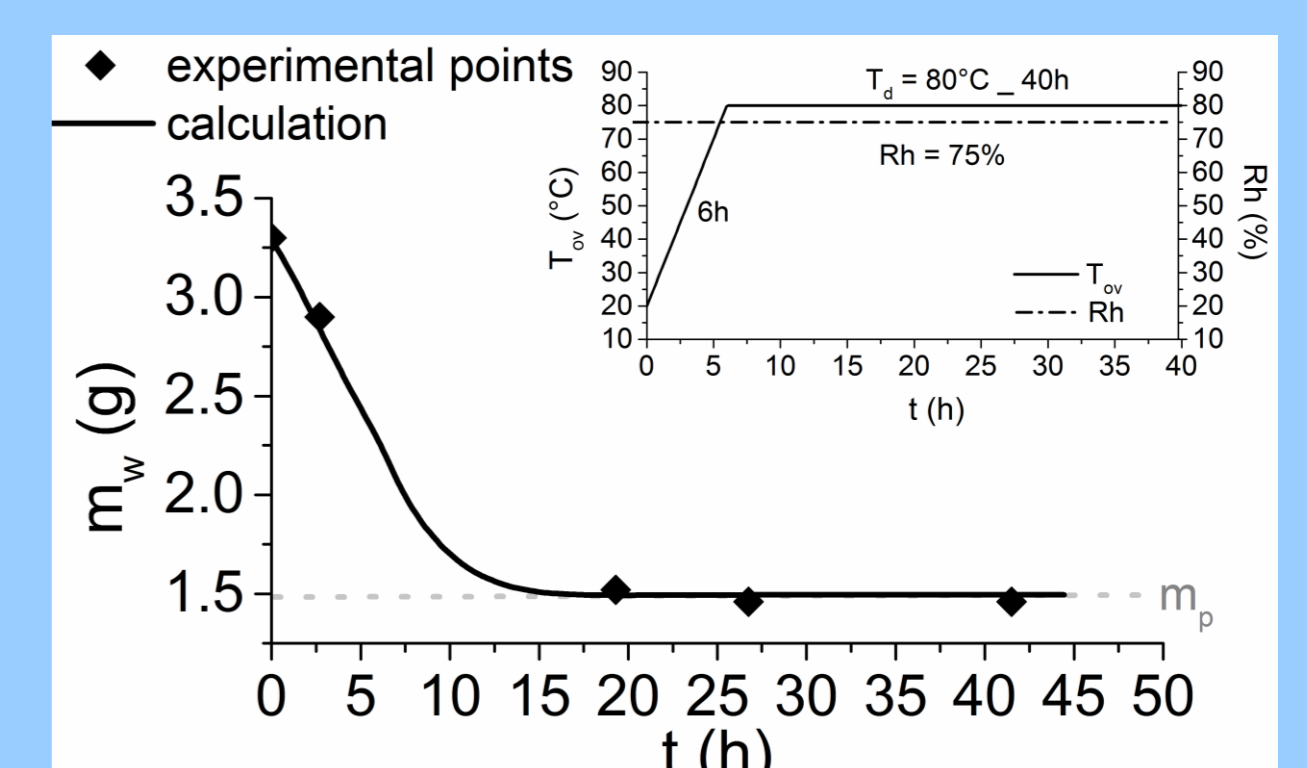
- Finite element method ⇒ **Minimization** of the water concentration gradient $\nabla C_{max}^{vol,t}$
 ⇒ **Minimization** of the final water content
 ⇒ **Minimization** of the process duration



Definition of the water activity: $P_v = a_w * P_{sat}$

$$a_w = \left[1 + \left(\frac{A}{X} \right)^B \right]^{-1}$$

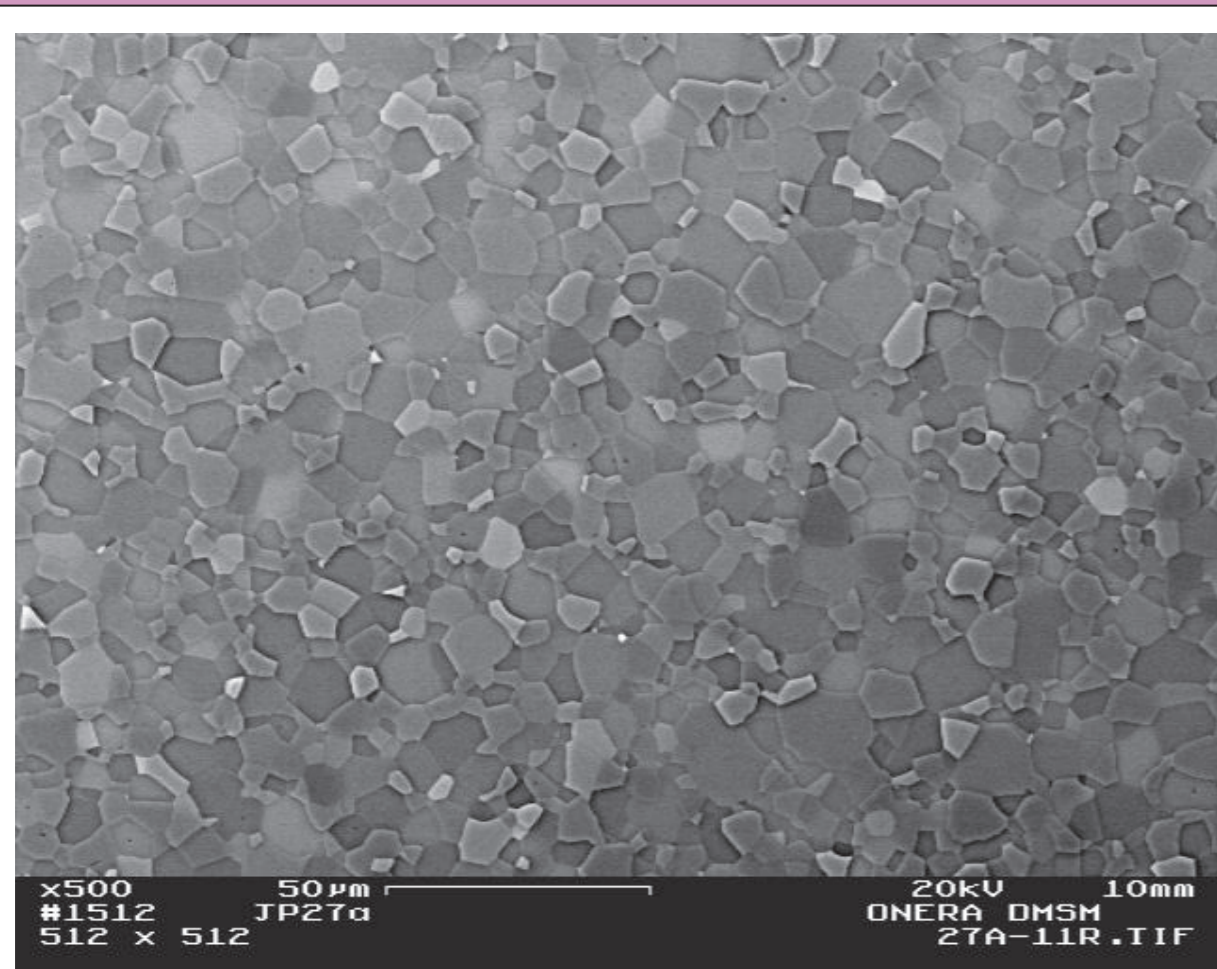
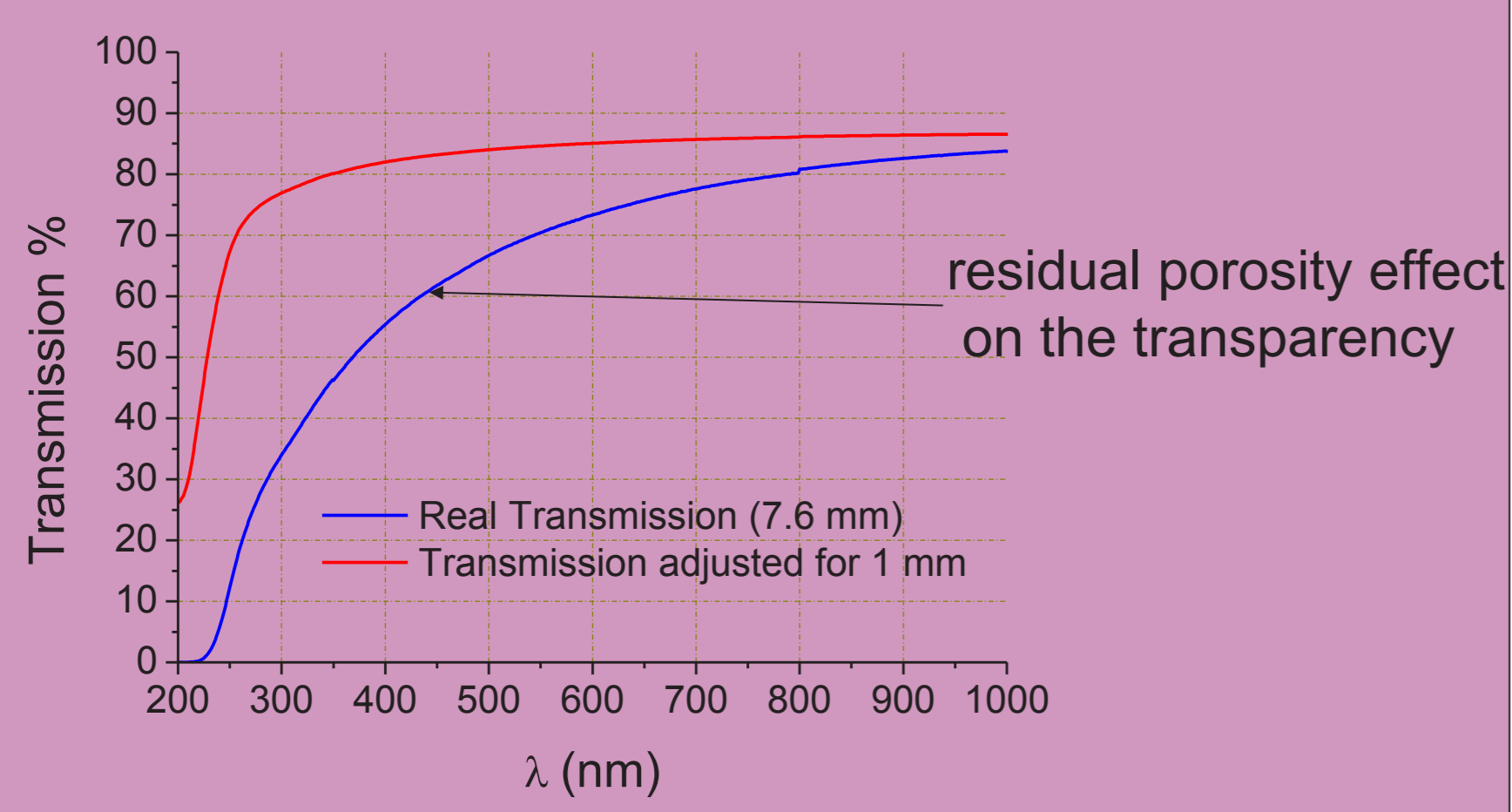
Adjustment of A and B parameters
Fitting experimental curves



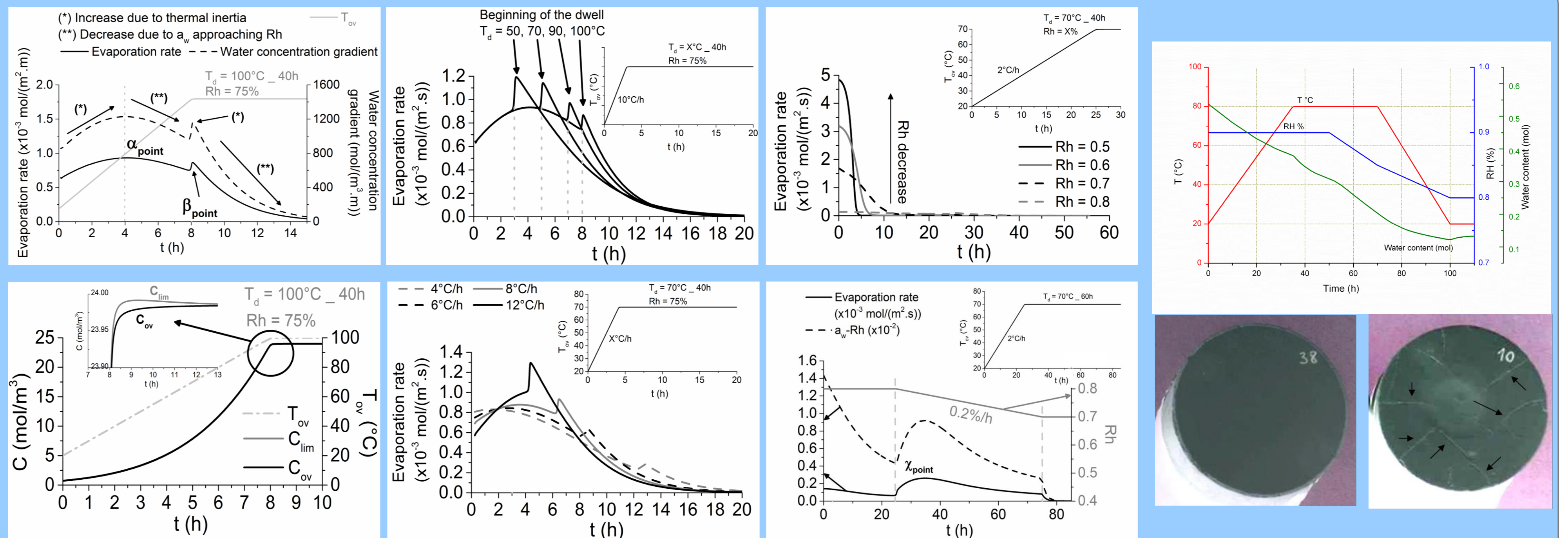
Results and Characterizations



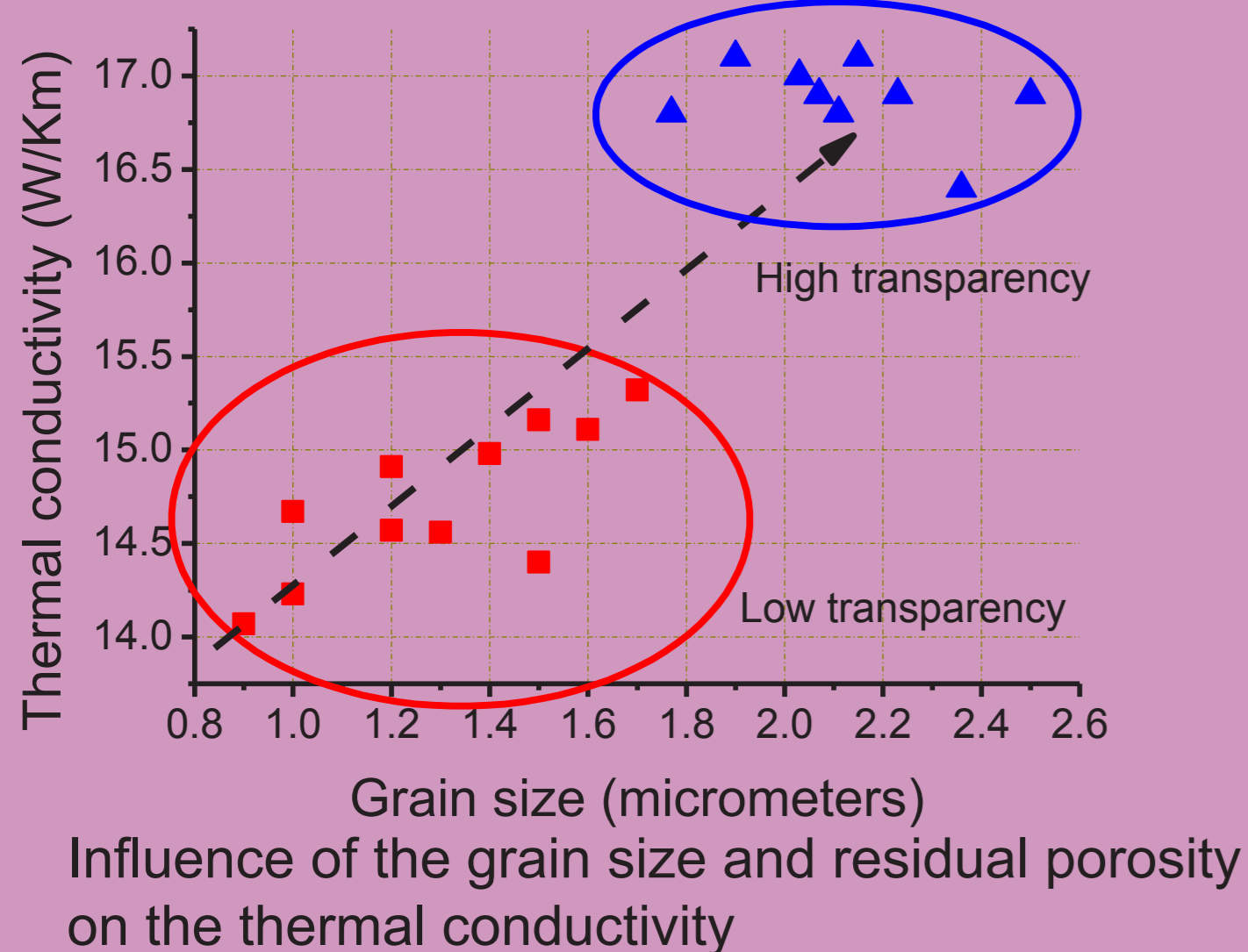
Ø75xh10 mm



Optimization of the drying program



Other materials



Alumina



Yttria