

## THERMAL SHRINKAGE PROFILE OF DOPED YAG FOR LASER APPLICATIONS

### INTRODUCTION

Yttrium Aluminium Garnet ceramics (YAG) have found applications in the military equipment, mostly as amplification cavity in laser for target designation and range finding. Optical properties of these materials can be tailored by addition of doping elements. But the impact of doping on the materials processing is a key point to study.

In this example, the effect of Ytterbium (Yb) doping was studied. One important step of ceramic processing is sintering, which can be characterized by thermomechanical analysis, as it is associated with important dimensional change.

### EXPERIMENT

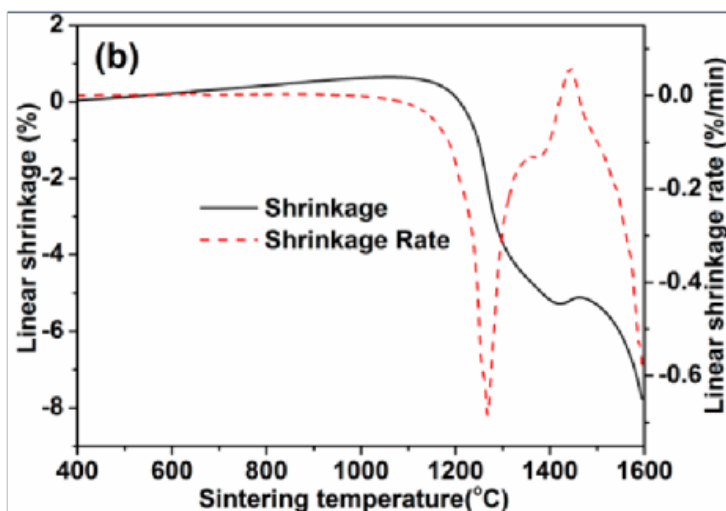
**Sample:** 1% Yb doped YAG

**Experimental conditions:**

- Themys TMA
- 20°C to 1600°C at 10°C/min
- Atmosphere: O<sub>2</sub>

**Results:**

- Linear expansion up to 1100°C
- Shrinkage above 1100°C :
  - Monoclinic (YAM) until 1250°C
  - Perovskite (YAP) until 1450°C
  - Garnet (YAG) from 1450°C



### RESULTS AND CONCLUSION

During heating, a linear dimensional increase is first measured up to 1100°C. It is due to thermal dilatation. Coefficient of thermal expansion can be measured during this phase.

Above 1100°C, shrinkage is measured, with at least 3 regimes associated with variation in shrinkage rate. It is explained by the phases formed during heating: the YAM (Yttrium Aluminum Monoclinic - Y<sub>4</sub>Al<sub>2</sub>O<sub>9</sub>) phase is usually formed first, followed by YAP phase (Yttrium Aluminum Perovskite - YAlO<sub>3</sub>) and finally YAG.

### INSTRUMENT

#### THEMYSTMA



**PRESERVATION OF SAMPLES**  
due to low load vertical TMA system.

**ULTRA-HIGH TEMPERATURE CAPABILITY**  
to 2400°C with a single furnace.

**MODULAR ADAPTIONS ALLOWING**  
TGA only, DTA only, TG-DTA, and TMA up to 2400°C,  
DSC only and TG-DSC up to 1600°C all in one  
instrument.

**EXTERNAL COUPLING CAPABILITY**  
designed for evolved gas analyzers (FTIR, MS, GCMS,  
MSFTIR, or FTIR-GCMS)

Reference: Li, J.; Liu, X.; Wu, L.; Ji, H.; Dong, L.; Sun, X.; Qi, X. *Coatings* 2022, 12, 1155