



Optical and mechanical performances of IR transparent CaLa₂S₄ ceramics

*DURAND G.*¹, *LALLEMANT L.*¹, *COUREAU C.*¹, *GAUTIER A.*², *JOUAN T.*², *ZHANG X.*², *BOUSSARD C.*², *MERDRIGNAC-CONANEC O.*²

¹ Solcera Advanced Materials, 27000 Évreux, France; ² Univ. Rennes, CNRS, ISCR (Institut des Sciences Chimiques de Rennes) - UMR 6226, 35000 Rennes, France

Chalcogenide transparent ceramics are key materials for IR optical applications and thermal imagery. They exhibit larger transparency windows, compared to oxides or fluorides, up to the Long Wave Infrared range (LWIR). Moreover, they show better mechanical properties than chalcogenide glasses with similar optical windows.

Zinc sulfide (ZnS) is the reference material for IR windows and domes in atmospheric conditions, due to its wide transparency window (from visible to 12 μm) and good resistance to thermal shock. Yet, the use, in harsh conditions, of the commercially available ZnS ceramic (obtained by CVD + HIP process) is limited due to its bad rain-erosion resistance, mostly due to its low hardness ($\text{HV} \approx 250 \text{ kg/mm}^2$).

In order to improve the rain-erosion resistance of IR windows, Solcera and the University of Rennes investigate new chalcogenide materials. The ternary sulfide CaLa₂S₄ (CLS) is a promising candidate for the replacement of ZnS ceramics. CLS exhibits similar transparency windows (from 0.5 to 14 μm) but twice the hardness of ZnS.

CLS is a refractory sulfide (melting point above 1810°C) with cubic structure (Th₃P₄ type, *I-43d*). Continuous solid solutions exist between the nominally stoichiometric CaLa₂S₄, the γ -La₂S₃ and the metallic La₂S₄. The control of the stoichiometry of CLS materials is thus a key parameter to achieving the foreseen optical properties. Powders were obtained by a combustion synthesis followed by a thermal treatment in sulfurizing conditions. The densification of IR transparent ceramics is investigated by various densification techniques such as Hot Pressing (HP), natural sintering under sulfurizing atmosphere and Hot Isostatic Pressing (HIP). The phase composition, the stoichiometry and the microstructure of sintered materials were characterized and compared in order to investigate the relationship between the sintering techniques and the optical and the mechanical properties.

Acknowledgements:

This work is part of the ANR-Astrid Maturation project CaLaSIR. We would like to thank the ANR, the French Direction Générale de l'Armement (DGA) and the Ministère des Armées - Agence de l'Innovation de Défense (AID) for their financial support.

Keywords: Transparent ceramics, sulfides ceramics, powder synthesis, Hot Isostatic Pressing, microstructures