Al₂O₃-based directionally solidified eutectic ceramics have received recent attention as structural materials, particularly because of excellent microstructural and chemical stability, creep resistance and mechanical strengths in high-temperature oxidizing atmosphere [1]. Very high values of flexural strength, that increases with decreasing interphase spacing ($\lambda$), have been observed. This strength comes about by the homogeneous two-phase microstructure, strongly bonded interphases and with fine control over the microstructural size, that is achieved by directional solidification procedures. Alumina-rare earth garnet eutectics present also selective emissivity and have been proposed and investigated as selective thermal emitters for thermophotovoltaic devices. [2] Appropriate thermal stress resistance is required for this application, but the detailed study of the thermal shock behavior was lacking.

Al₂O₃-aluminium garnet directionally solidified eutectics have typically a high degree of brittleness (with Indentation Fracture Toughness $\approx 2$ MPam$^{1/2}$), relatively low thermal conductivity, and high Young’s modulus, being susceptible to catastrophic failure under severe thermal transients. Experiments to measure thermal emission which imply fast cooling in ambient air from 1600 °C, show that they can support moderate thermal shock conditions without apparent degradation. In this work we study the thermal shock behavior of directionally solidified Al₂O₃-Er₃Al₅O₁₂ eutectic selective emitters with emphasis on the microstructural size dependence. The outcome will be applicable to similar alumina-garnet eutectics.

It is shown that Al₂O₃-Er₃Al₅O₁₂ eutectics with finer microstructure are better, not only when high flexural strength is required, but under circumstances where relatively mild thermal shock conditions are to be found. These are for example, quenching in boiling water or free cooling in air of selective thermal emitters. The reason for the better response of fine micro-structured, strong eutectics over coarser ones resides on the first nucleating a larger amount of propagating thermal cracks at Al₂O₃-Er₃Al₅O₁₂ interface boundaries. It is important to emphasize also that to rank eutectics of this kind for thermal shock resistance, which possess large flexural strength, one should prioritize minimum mismatch of the thermal conductivity and thermal expansion values among the component phases, together with large thermal stress stability parameter ($R_{st}=K_{ic}/\alpha E$). This would increase the temperature difference at which the cracks start to grow and diminish the final size of the propagated cracks, respectively.