Selective Emitters for Thermophotovoltaics Based on Eutectic Composites

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Directionally solidified oxide eutectics showing good thermomechanical properties have been proposed as selective emitters for application in thermophotovoltaic (TPV) devices, and several works were published in the early 2000’s to investigate their emissive properties. [1] Their selective emissivity resides in the content of rare earth oxides or transition metal ions with absorption band in the desired spectral range, suitably matched to the absorption of photovoltaic cells.

Porous coatings [2] or ceramic fabrics [3] were investigated in lab-scale devices, as they need to withstand sudden temperature changes. The advantage of solidified eutectics over porous ceramics is that, being dense, light scattering is weaker. Therefore, thermal emission exiting the sample is generated in a larger depth below the surface, and broadening of the emissive band due to small absorbing tails or defects in the material can be smaller, and consequently the emitter is more selective.

Directionally solidified oxides can be produced in bulk by different procedures such as Bridgman, micro-pulling-down or laser floating zone (LFZ). They can also be prepared in the form of dense coatings on different substrates, thereby allowing manufacture adapted to the TPV device. In our laboratory we have used both kinds of procedures to prepare thermomechanical resistant eutectics that host rare earth or transition metal ions. More specifically, Al₂O₃-Y₃₋ₓErₓAl₅O₁₂ and Ni-doped MgO-MgSZ directionally solidified eutectics, and investigated their thermal-shock resistance [4] and the characteristics of their selective emission [5, 6]. Al₂O₃-Er₃Al₅O₁₂ (and other Al₂O₃-rare earth ion garnet) present very selective emission bands, with small broadening with temperature. On the contrary, Ni doped MgO-MgSZ presents severe broadening with small doping levels at high temperatures, as also observed in doped MgO, limiting the selectivity.

The purpose of this communication is to present the state of the art of the research of our team in the subject [7]. Nowadays we are particularly interested in the propagation of light in these microstructured materials, and how it can affect to the thermal emission.

References

[7] This work has been supported by the Spanish Ministerio de Economía, Industria y Competitividad (MINECO) and the CE (FEDER Funds) [grant number MAT-2016-77769R-FLASERAMAT], and by the Departamento de Innovación, Investigación y Universidad de la DGA [grant number T02-17R].]