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Experimental features affecting the transparency of YAG materials

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Abstract

The important role played by the processing on the transparency of ceramic materials is often underestimated. In the literature a high level of transparency has been reported by many authors that for years focused their research on the development of polycrystalline YAG for laser applications, but the description of the experimental process is seldom thoroughly described. A detailed description of the powder treatment and shaping and of other important information that are necessary to reproduce the described results, is often missing. In order to be transparent a ceramic material must exhibit a very low concentration of defects such as secondary or grain boundary phases and residual pores. In order to fulfill this requirement specific experimental conditions must be combined together. Powders need to be nanometric or at least sub-micrometric and extremely pure. On the other hand, nanometric powders aggregate easily and the poor packing that may derived can lead to residual porosity. In addition, very fine powders are difficult to handle and tend to absorb water on the surface. Finally, the powder manipulation (weighting operations, solvent removal, spray drying, shaping, etc), easily introduces impurities. In case of transparent materials all these features must be controlled because they lead to the formation of defects that works as light scattering sources thus decreasing the transparency. This work describes the results obtained with YAG based ceramics under different experimental conditions of powder treatment and shaping. Commercial powders are used for the reactive sintering in a clean atmosphere and under high vacuum of YAG materials doped with Nd, Yb or Er. These dopants have been selected as the more appropriate for high power lasers. The powder treatment (ball milling duration and speed, suspension concentration, solvent/powder ratio, type and amount of dispersant) the solvent removal technique (spray drying conditions, rotavapor temperature, etc.) are described in detail as well as the conditions adopted during shaping. The influence of the powder process on the powder packing during shaping by pressing is also reported. Finally, the influence of the pre-sintering and sintering cycles is also described.