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Abstract.

Polycrystalline ceramics, namely magnesium aluminate spinel and YAG, are attractive materials for a wide range of armor and civilian applications. Mechanical properties as well as the optical transmittance of polycrystalline ceramics are controlled by microstructural features such as grain size, porosity and presence of second phases. For high level transparency of polycrystalline ceramics it is important to create a microstructure that contains a minimal fraction of scattering centers (pores, inclusions and grain boundaries) In fully dense single phase ceramics, the transparency level increases with increasing grain size on account of the decreasing fraction of grain boundary regions. On the other hand, the mechanical properties (strength and hardness) of the polycrystalline ceramics with the average grain size larger than 0.5 μm significantly decrease. Thus, the optical transmittance and the mechanical properties of the polycrystalline ceramics change with grain size in opposite directions and an optimal compromise between the two functional properties of the ceramics has to be determined and realized. For sintering of the ceramic nano-powders we apply spark plasma sintering (SPS). This relatively novel sintering approach allows fabricating submicron and even nano-structured ceramics. The main focus of our investigation is to determine the optimal parameters of the SPS process for the fabrication of dense polycrystalline ceramics, which display the functionality required from the final product.

For instance, maximal transparency (80%) of the SPS-processed spinel specimens was achieved using LiF-dopped ceramic powder and with an average grain size of about 40μm. These specimens display a hardness value of about 1450HV and a bending strength of about 150MPa. At the same time, the adequate level of

transmittance (77% for 1000nm and 68% for 500nm) was achieved for the undoped specimens fabricated at 1300°C at a heating rate of 2°C/min. These specimens have submicron structure and display significantly higher mechanical properties (HV of about 1600 and bending strength of about 300MPa).

Speciemens of transparent Spenel and Nd-YAG and their microstructure and optical transparency are shown in Fig.1-6

Fig.1. Transparent spinel specimens

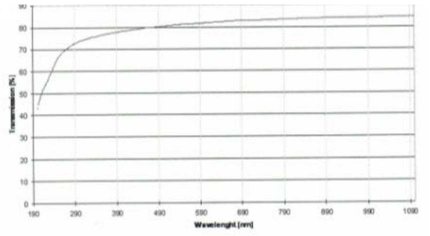

Fig. 2. Transparency of polycrystalline spinel.

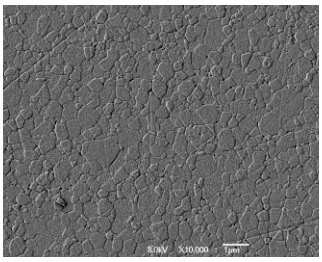

Fig.3. Sub-micron microstructure of transparent spinel

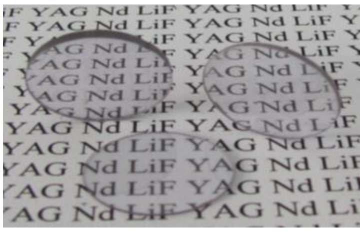

Fig.4. Transparent Nd:YAG specimens

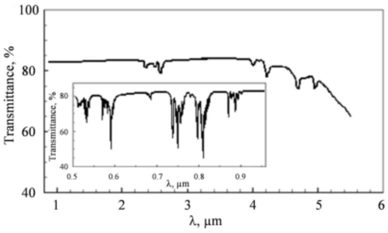

Fig.5. Transparency of polycrystalline spinel.

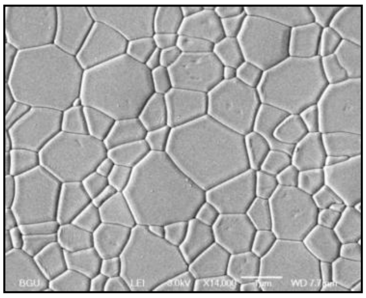

Fig.6. Microstructure of transparent Nd:YAG