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Discoloration of spark–plasma–sintered transparent MgAl2O4 spinel

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Discoloration of Spark-Plasma-Sintered Transparent $MgAl_2O_4$ Spinel

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It is reported that the spark-plasma-sintered (SPSed) transparent oxides exhibit a discoloration. The discoloration is known to be more remarkable in the SPSed oxides than the HIP/HP processed ones. In order to understand the discoloration phenomena, the discoloration was investigated by spectroscopic techniques using a spinel ($MgAl_2O_4$) as the reference material.

The discoloration is explained by the combination of carbon contaminations and lattice defects (color centers), which are introduced in the spinel matrix depending on the SPS conditions. For high heating rate of ≥50°C/min, carbon contamination occurred by evaporating the carbon phases from the carbon papers and graphite dies during the heating process and tended to be enhanced by the increasing heating rate. For the high heating rate of α = 100 °C/min, although the carbon contamination occurs over almost the entire region of the spinel plate with a 3 mm thickness, the amount of the contamination is significant around the surfaces. The color center (F^+-center) may be generated by the formation of oxygen vacancies, which are mainly introduced by dislocation motion depending on the sintering conditions. Since the rate of sintering, namely the deformation rate, increased with the heating rate, the concentration of the dislocation-related color centers increased with the heating rate, but decreased with the sintering temperature due to the bleaching of the oxygen vacancies. For the present spinel, the discoloration due to the carbon contamination and the formation of F^+-centers deteriorates the light transmission depending on the sintering conditions.