SPARK PLASMA SINTERING OF TRANSPARENT $MgAl_2O_4$ CERAMICS WITH THE USE OF COLLECTOR PRESSING*

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Transparent ceramics based on magnesium aluminate spinel ($MgAl_2O_4$, MAS) is one of the most promising optical materials. Research on transparent MAS ceramics has been conducted since the 60s of the twentieth century. Most of the developments are aimed at obtaining transparent material, the use of which is possible in aerospace, optoelectronics and laser industries. In recent years, MAS ceramics are used to manufacture optics elements of space telescopes, output windows of ultraviolet and infrared laser devices, and elements of passive optics operating under extreme conditions [1,2].

Transparent MAS ceramics is produced by several technologies. The most perspective among them is spark plasma sintering (SPS). The SPS technique combines simultaneous compression and thermal action on the material. Controlling of various parameters during the SPS process (temperature, pressure, holding time, heating and cooling rate, pulse relative duration) in a wide range allows fabrication of the various materials with controlled properties, from nano- to sub-micropowders, and optimization the sintering process according to various criteria [3,4].

One of the problems of the SPS technique which has received less attention in the literature is the fabrication of materials with complex shapes. The solution to this problem is the approach of combining the SPS with alternative compaction schemes for powder materials, such as collector pressing scheme [5].

In this work, the SPS technique in combination of the collector pressing method is used to sintering transparent MAS ceramics with an increased shape form. The mechanical and optical properties of transparent MAS ceramics obtained were studied.

MAS ceramics were sintered from commercial nanopowder using with the use of spark plasma sintering method combined with collector pressing scheme (CP): SPS+CP method.

The results of measuring the in-line transmittance at wavelength 600 nm ($T_{\lambda=600nm}$), microhardness (H_V), fracture toughness (K_{1C}), Young modulus (E), shear modulus (G) of obtained ceramics are represented in table 1.

Table 1 – Optical and mechanical properties of spark plasma sintered MAS ceramics with an increased shape factor

Method	$T_{\lambda=600nm}$, %	H_V, GPa	K_{1C}, $MPa^{0,5}$	E, GPa	G, GPa
SPS	38,5	16,9±0,8	3,38±0,18	323,4	127,9
SPS+CP	41,3	17,1±0,8	2,67±0,12	351,4	139,0

It has been shown that translucent $MgAl_2O_4$ ceramics with an increased shape factor can be successfully fabricated by the SPS technique combined with the collector pressing scheme. The optical and mechanical properties of ceramics obtained with use of collector scheme is comparable to the similar properties of ceramics obtained using conventional uniaxial pressing scheme.

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