APPLICATION OF THE COLLECTOR PRESSING FOR SPARK PLASMA SINTERING OF THE OPTICAL TRANSPARENT OXIDE CERAMICS *

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A large number of studies devoted to the development of transparent ceramics manufacturing technology are discussed in detail in review papers [1-3]. Despite the obvious advantages of transparent polycrystalline materials, their industrial application, until now, is very limited, since the optical quality of these materials is lower than that of their single-crystal and amorphous analogues [1-4]. In this regard, the development and optimization of the production technology of optically transparent polycrystalline materials for various industrial applications remains a very important task of material science. Transparent ceramic has several advantages over its single-crystal counterparts. For example, high mechanical properties, the ability to organize cost-effective large-scale production, the ability to control the shape, size and properties [5].

Promising from the standpoint of improving the quality of transparent ceramics and expanding the product range is the use of rational deformation schemes in the spark plasma sintering (SPS) method. These schemes are deprived the disadvantages of a uniaxial scheme. For example, collector pressing schemes [6]. It provides a uniform distribution of density in the volume of the powder body, which in turn can help to reduce the minimum pressure required to obtain transparent products.

In this work, the mechanical and optical properties of transparent ceramics based on YSZ and Ce:YAG were studied. Ceramics were fabricated by spark plasma sintering (SPS) using various pressing schemes.

Transparent ceramics based on yttrium stabilized zirconia (YSZ) and yttrium-aluminum garnet doped with ceria (Ce:YAG) were consolidated from commercial initial powders using SPS technique combined with method of collector pressing (CP): SPS+CP method.

The use of a collector pressing scheme made it possible to obtain ceramics with acceptable optical and mechanical properties at temperature 1300 ºC and 1600 ºC for YSZ and Ce:YAG respectively, under progressive uniaxial loading at 40 MPa.

The results of measuring the optical (in-line transmittance T and optical density D) and mechanical properties (Young modulus obtained by nanoindentation E_{it}, creep strain at indentation load C_{it} and Vickers microhardness H_{V200}) of obtained ceramics are represented in table 1.

Table 1 – Optical and mechanical properties of spark plasma sintered ceramics

Ceramics		H_{V200}, ГПа	E_{it}, ГПа	C_{it}, %	$T_{\lambda=600nm}$, %	$D_{\lambda=600nm}$, 1/cm	$T_{\lambda=1100nm}$, %	$D_{\lambda=1100nm}$, 1/cm
YSZ	SPS	14,47±0,71	127,7±1,5	1,63±0,24	31,58	9,48	57,68	4,74
YSZ	SPS+CP	15,52±0,41	143,8±7,4	3,03±1,03	34,58	6,01	63,14	3,65
Ce:YAG	SPS	15,01±1,05	171,5±11,7	1,56±0,45	23,54	19,49	28,15	16,01
Ce:YAG	SPS+CP	15,82±0,86	167,1±6,4	1,82±0,56	26,44	18,17	31,7	15,92

Thus, it was found that collector pressing during the SPS improves the optical properties (increase T in visible region by 2,9 – 3 %; in near infrared region by 3,55 - 5,46 %) and does not significantly affect the mechanical properties of transparent ceramics.

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