

Topic: ICT-03-2019: Photonics Manufacturing Pilot Lines for Photonic Components and Devices (IA)

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Deadline: 28th March 2019

Description of the offered expertise

Polycrystalline transparent ceramics provide properties that cannot be obtained in other transparent materials. They can be used in extreme conditions where other optical materials do not meet the requirements for high thermo-mechanical properties (polymers, glass) or are difficult and expensive to produce in large and complex shapes (ceramic single crystals). Another benefit of ceramic materials is relatively high refractive index.

Our group has developed a new processing method for preparation of highly transparent polycrystalline alumina parts. The method utilizes a novel combined densification process enhanced by a unique nanoparticle doping approach that provide planar alumina with the highest in-line transmittance (@630 nm) ever reported. The developed processing approach features near-net shape and scale-up capabilities and can be used for transparent armours, wear resistant and high temperature windows, protective domes, lighting devices, etc. The processing approach is generally applicable and can also be utilized for other polycrystalline ceramics.

An additional functionality of transparent ceramics has been developed via doping by rare-earth elements or transition elements. The method is based on proper treatment of dopants combined with novel pressure-less presintering followed by hot isostatic pressing. Er-doped alumina prepared by this approach exhibits the highest in-line transmittance reported in the literature so far. These materials are currently tested as a host material in solid state lasers, or as a material for stabilization of laser frequency in atom clocks.

Description of potential role

The research activities of the group could include processing of highly transparent polycrystalline ceramic materials (Al_2O_3 , c-ZrO₂, t-ZrO₂, MgAl₂O₄, SiAlONs, etc) with complex shapes and/or processing of such transparent polycrystalline ceramics doped by phosphors (rare earth elements, transition metals) with high emissivity in the visible and near infrared region.

Reference to previous successful projects, products, patents and market applications (Max 5)

1. Projects dealing with transparent ceramics: 1 successfully finished projects (Grant Agency of the Czech Republic, 2013-15), and one running project (Czech Ministry of Education, 2018-2022)
2. Experience with EU projects: 2 successfully finished projects as a national coordinators (RP-DEMATEN No. 204953, 2008-2011, BioScaffolds No. 604036, 2013-2016)
3. Publications dealing with transparent (doped) ceramics: 9 (See Researcher ID Trunec (A-7957-2009) and Maca (D-7520-2012))
4. Main achievements:
 - Transparent alumina ceramics with the highest in-line transmission RIT = 76%
M. Trunec, J. Klimke, Z. J. Shen: J. Eur. Ceram. Soc. 36 (2016) 4333
 - Luminescent transparent ceramics with the highest in-line transmission
K. Drdlikova, R. Klement, Drdlik, T. Spusta, D. Galusek, K. Maca: J. Eur. Ceram. Soc. 37 (2017) 2695 (will be presented as an invited lecture at GOMD Meeting (<http://ceramics.org/gomd2018>), San Antonio, May 2018)
 - Transparent alumina dome (see <http://ceramics.ceitec.cz/research/>)