SAPPHIRE SHAPED CRYSTALS FOR OPTICALLY-BASED MULTIMODAL MEDICAL INSTRUMENTS

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Sapphire is characterized by a set of properties which make it an attractive material for medical instruments [1,2]. A combination of such properties as biocompatibility, high chemical and thermal stability, transparency in visible and partly infrared ranges, high hardness, and high thermal conductivity at low temperature enables application of sapphire for tissue resection, cryoablation, and light delivering for diagnosis and exposure [3-6]. The techniques of sapphire crystal growth, such as edge-defined film-fed growth and non-capillary shaping, allow for manufacturing of crystals with complex cross-section and shape, featuring high volume and surface quality [7]. The growth techniques equipped by the weight control system are used for manufacturing capillary needles, fibers, waveguides, tubes of constant and segmented shape, and ribbons with internal thin channels. Thus produced sapphire shaped crystals form the basis for such instruments as needles for minimally invasive interstitial laser and photodynamic therapy, diagnostic scalpel with coagulation modality, neuroprobes with tissue aspiration and coagulation modalities, cryoprobes for tissue cryoablation and therapy, as well as cryoprobes with optical monitoring of the ice ball formation.

Such sapphire-based medical instruments can open new opportunities of surgery, diagnostics and therapy, combining different modalities in one tool. In this talk, we summarize the recent developments in this field and discuss the abilities of sapphire multimodal instruments.

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[1] G.M. Katyba, et al., Prog. Cryst. Growth Charact. Mater. 64, 133–151 (2018).
[2] V.N. Kurlov, “Sapphire: Properties, growth, and applications,” in Encyclopedia of Materials: Science and Technology, K. J. Buschow, R. W. Cahn, M. C. Flemings, B. Ilschner, E. J. Kramer, S. Mahajan, and P. Veyssière (Eds.), Elsevier, Oxford, 8259–8264 (2001).
[3] I.N. Dolganova, et al., J. Biophotonics. 13(10), e202000164 (2020).
[4] G.M. Katyba, et al. Prog. Cryst. Growth Charact. Mater. 67(3),100523 (2021).
[5] I.N. Dolganova, et al. Lasers Surg. Med. 54, 611–622 (2022).
[6] I.N. Dolganova, et al. J. Biomed. Opt. 24(12), 128001 (2019).
[7] V.N. Kurlov, S. N. Rossolenko, J. Cryst. Growth 173, 417–426 (1997).
[8] V. Kurlov, J. Cryst. Growth 179, 168–174 (1997).