

## Two-wavelength High-energy Cr:LiCaAlF<sub>6</sub> MOPA Laser System for Medical Multispectral Optoacoustic Tomography

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**Abstract :** The development of medical optoacoustic tomography with the using human blood as endogenic contrast agent is constrained by the lack of reliable, easy-to-use and inexpensive sources of high-power pulsed laser radiation in the spectral region of 750-900 nm [1-2]. Currently used titanium-sapphire, alexandrite lasers or optical parametric light oscillators do not provide the required and stable output characteristics, they are structurally complex, and their cost is up to half the price of diagnostic optoacoustic systems. Here we are developing the lasers based on Cr:LiCaAlF<sub>6</sub> crystals which are free of abovementioned disadvantages and provides intensive ten's ns-range tunable laser radiation at specific absorption bands of oxy- (~840 nm) and -deoxyhemoglobin (~757 nm) in the blood. Cr:LiCAF (c=3 at.%) crystals were grown in Kazan Federal University by the vertical directional crystallization (Bridgman technique) in graphite crucibles in a fluorinating atmosphere at argon overpressure (P=1500 hPa) [3]. The laser elements have cylinder shape with the diameter of 8 mm and 90 mm in length. The direction of the optical axis of the crystal was normal to the cylinder generatrix, which provides the  $\pi$ -polarized laser action correspondent to maximal stimulated emission cross-section. The flat working surfaces of the active elements were polished and parallel to each other with an error less than 10". No any antireflection coating was applied. The Q-switched master oscillator-power amplifiers laser system (MOPA) with the dual-Xenon flashlamp pumping scheme in diffuse-reflectivity close-coupled head were realized. A specially designed laser cavity, consisting of dielectric highly reflective reflectors with a 2 m-curvature radius, a flat output mirror, a polarizer and Q-switch sell, makes it possible to operate sequentially in a circle (50 ns - laser one pulse after another) at wavelengths of 757 and 840 nm. The programmable pumping system from Tomowave Laser LLC (Russia) provided independent to each pulses (up to 250 J at 180  $\mu$ s) pumping to equalize the laser radiation intensity at these wavelengths. The MOPA laser operates at 10 Hz pulse repetition rate with the output energy up to 210 mJ. Taking into account the limitations associated with physiological movements and other characteristics of patient tissues, the duration of laser pulses and their energy allows molecular and functional high-contrast imaging to depths of 5-6 cm with a spatial resolution of at least 1 mm. Highly likely the further comprehensive design of laser allows improving the output properties and realizing better spatial resolution of medical multispectral optoacoustic tomography systems.

**Keywords :** medical optoacoustic, endogenic contrast agent, multiwavelength tunable pulse lasers, MOPA laser system

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