Fluoride Fiber Lasers Sources for Medical Applications

Marcel Poulain*[1,2], Samuel Poulain , Franck Joulain , Laurine Bodin , and Solenn Cozic

[1]Le Verre Fluore (LVF) – LVF – Campus Kerlann 35170 Bruz, France
[2]Verres et céramiques (VC) – Université de Rennes I – bat. 10 Av du général Leclerc 35042 RENNES CEDEX, France

Abstract

Fiber lasers are increasingly used in various fields: industrial, environment, biomedical, defense... Their main advantages over classical lasers are their power, their efficiency and reliability. Until now they are based on silica fibers, and they are operating in limited spectral range, mostly in the near infrared.
While laser emission is usualy confined is a narrow bandwidth, supercontinuum sources are now available to operate in a broad spectral range, typically between 400 and 2400 nm.

Fluoride glass fibers are opening new prospects with the development of fiber lasers at 2.9 μm with output power in excess of 30 W in CW operation [1]. Experimental lasers have been reported at 2.3 μm and 3.55 μm. Fiber lasers emitting beyond 4 μm are now considered.

Mid-IR supercontinuum sources based on fluoride fibers are now available. Their emission extends to 4 to 5 μm, typically from 0.8 up to 4.8 μm, with more than 1 W average output power.

YAG:Er laser at 2.94 μm is used in dentistry and laser surgery. Optical fibers make easier beam handling. This is the case for ZBLAN fibers that withstand 1.6 J pulses at 2.94 μm. This wavelength corresponds to the maximum absorption coefficient of water, which makes it an excellent laser for surgical cutting. In these conditions, laser ablation does not induce heating of underlying tissues. It is expected that fiber laser will replace YAG:Er in various cases. In addition to compactness and reliability, its unique beam quality ensures higher precision and lower required power, as shown by preliminary experiments.

Medical diagnosis may be achieved by absorption/reflection spectroscopy. Limits arise from the intensity of the illuminating source. By comparison to standard components, infrared supercontinuum sources are brighter by several orders of magnitude. This could lead to a breakthrough diagnostic technology that replicates measurements made with synchrotron beam. A first field of application relates to skin cancer. In vivo experiments could be investigated using optical fiber probes.

V. Fortin, M. Bernier, S. T. Bah, et R. Vallée, *Opt. Lett.*, 40, 2882 (2015).

*Speaker

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