Low loss fluoride optical fibers: properties and application

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Abstract

Heavy Metal Fluoride Glasses (HMFG) were discovered in 1974 by Poulain *et al.* [1]. More than 40 years later, tremendous research and development efforts have resulted in a notable improvement of fluoride fibers quality. Their optical transmission in the mid IR extends up to 4.2 μm for fluorozirconate glass fibers and 5.2 μm for fluoroindates with minimum losses reaching 1.04 dB/km ad 2.2 dB/km for these fibers, respectively.
Present fibers pave the way to numerous passive applications.

- Remote detection of optical signals from 0.5 up to 5.5 μm (Spectrometry, Thermometry).
- Pigtailing Quantum Cascade Lasers from 2 up to 5 μm.
- Low birefringence fibers for astronomical instruments.
- Polarization maintaining fibers (airgap, panda, elliptic core fibers) for instrumentation.
- Laser power transmission, e.g. Er:YAG laser. Indeed, ZBLAN fibers withstand 1.6 J pulses at 2.94 μm. At other wavelengths they can handle more than 188W continuous wave laser beam.

Applications for active fibers are based on rare-earth-doped fibers or on non-linearity. Fluoride glass fibers offer two main advantages for active applications: their high solubility of rare earth ions, up to 10 mol % and their low phonon energy: 580 cm-1 for ZBLAN and 510 cm-1for fluoroindate glass. As a consequence, laser transitions are possible from energy levels that are inactive in silica fibers. For example, lasing around 2.8 μm has been reported, with a record value of 30.5 W at 2.94 μm in CW operation [2].

Optical nonlinearity is small in fluoride glasses. However, low optical losses make possible to use long fiber lengths. As a result, supercontinuum laser sources have been developed in a broad spectral range, typically from 0.8 up to 4.8 μm. Also, deep-ultraviolet supercontinuum starting from 200 nm has been demonstrated using photonic crystal fluoride fiber [3]. Fluoride fibers are less sensitive to ultraviolet related optical damages than silica fibers.

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