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CFJ5 Ytterbium fiber lasers: versatile sources for the 1–1.2-μm region.

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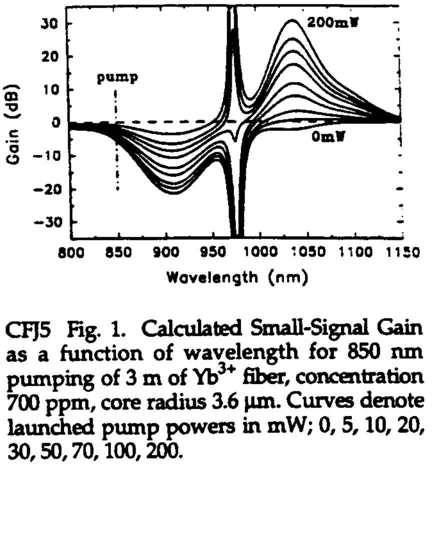
Ytterbium-doped silica fibers can offer very versatile laser sources in the 1–1.2-μm region with a wide range of possible pumps and operating wavelengths. In particular operation is possible from 980 nm to at least 1.18 μm.[1,2] This range covers operation at 1.017 μm, suitable for up-conversion,[3] or for the 1.3 μm amplifier[4] in Pr^{3+} ZBLAN fiber, and operation at 1.12 μm suitable for up-conversion in Tm^{3+} ZBLAN.[5] We report here experimental results and modeling aimed at optimizing performance of Yb^{3+} fiber lasers for these various applications. Figure 1 shows, from the modeling, calculated gain vs wavelength for a particular fiber, illustrating the broad range of absorption and emission. Despite the very weak absorption at 1.047 μm and 1.064 μm, seen in the figure, pumping at these wavelengths proves to be an effective way of generating yet longer wavelengths since it excludes the possibility of gain at shorter wavelengths and in particular prevents competition from gain on the emission peaks at 0.974 μm and 1.04 μm. Thus, using a wavelength of 1.047 μm to pump 100 m of Yb^{3+}-doped germano-silicate fiber (concentration: 700 ppm, radius: 6 μm, NA: 0.17) in a laser resonator consisting of a butted high reflector at the input and the Fresnel reflection at the output, we have measured 600 mW of cW output power at 1115 nm for ~2W of pump power. The threshold and slope efficiency, with respect to absorbed power, were 270 mW and 62% (with a 45% launch efficiency), respectively. The gain actually exceeded 14 dB, since lasing occurred, at 1100 nm, with feedback provided purely by the two Fresnel reflections from the cleaved fiber ends. Further experiments into the high power limit and the selection of other wavelengths, including the use of fiber gratings, are being carried out and will be reported.

Laser sources at these wavelengths are of particular relevance for the Tm^{3+} ZBLAN up-conversion fiber laser operating at around 480 nm, as demonstrated by Grubb *et al.*[5] In fact, we have confirmed the usefulness of the Yb^{3+} fiber laser described here by using it, operating at 1.114 μm, to pump a Tm^{3+}-doped ZBLAN fiber, successfully obtaining lasing emission at 480 nm.

In Pr^{3+} ZBLAN fiber, pumping at 1.017 μm is required, both for the 1.3 μm amplifier and for the first step for visible up-conversion. The Ytterbium fiber laser offers a possible source for both these applications, with the convenience of pumping by AlGaAs diodes in the 800–850 nm region. As seen from Fig. 1, which corresponds to an 850 nm pump, substantial gain is readily achieved arour 1.017 μm. However, it is necessary to discri inate against the higher gains available on t 0.974 μm and 1.04 μm transitions, and expe iments are in progress using fiber gratings select desired wavelengths. The results these experiments will be reported.

1. D. C. Hanna *et al.*, J. Modern Optics **37** 329–331 (1987).
2. Gapontsev *et al.*, paper WC1, Advanced Solid State Lasers, Hilton Heac South Carolina, Mar. 1991.
3. R. G. Smart *et al.*, Elect. Lett. **27**, 1307–1308 (1991).
4. Y. Ohishi *et al.*, Opt. Lett. **16**, 220, (1991
5. S. G. Grubb *et al.*, Elect. Lett. **28**, 1243–1244 (1992).



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