CFJ6 320-mW Nd^{3+}-doped single-mode fiber superfluorescent source

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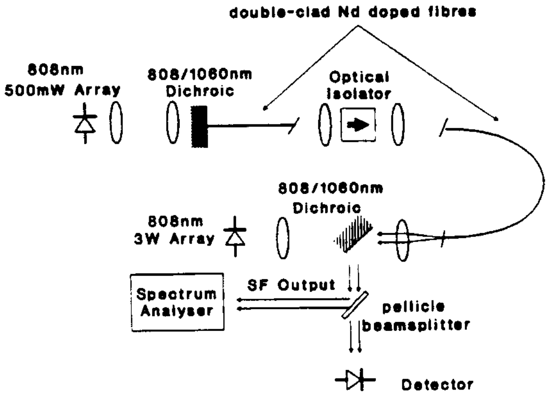
Superfluorescent, SF single-mode Nd^{3+} doped fiber sources[1,2] are of interest for use in a number of applications where a high brightness source of low temporal coherence is required. These include sensors such as fiber gyroscopes and medical diagnostics. Such sources are similar to fiber lasers, but suppression of round-trip feedback prevents the formation of discrete longitudinal cavity modes. The amplified spontaneous emission thus maintains a continuous spectrum. By pumping special double-clad fibers with multistripe diode arrays, powers of up to 80 mW have been achieved.[3] However, the output power is limited by a tendency to lase around line center when the product of the fiber gain and the effective reflection induced by Rayleigh backscattering exceeds unity. In this paper we report a scheme whereby this limitation is overcome by injecting light from a relatively low-power fiber SF seed source into a high-gain fiber amplifier. Using this technique we have demonstrated output power approximately four times that previously reported.

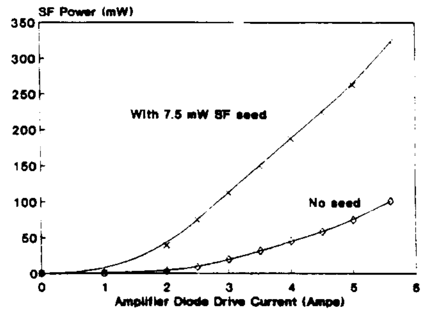
Double-clad fibers comprising a doped single-mode core within a multimode waveguide enable pump light from a low brightness multimode pump source such as a diode array to be efficiently absorbed by a single mode core.[4,5] For our SF source we employ a lead silicate double-clad fiber comprising a heavily Nd^{3+}-doped (3wt%) core of Schott F7 glass (NA = 0.13, diameter = 5.3 μm) located centrally within a rectangular highly multimode undoped inner-cladding waveguide of Schott F2 glass into which the pump light is injected. This inner cladding is in turn clad with Schott LF8 to give a high numerical aperture (NA = 0.42) and a circular fiber cross section. Full details of the fiber design can be found in Ref. 5.

The experimental arrangement comprising the seeded SF source is shown schematically in Fig. 1. The system comprises two 808-nm diode arrays (500 mW and 3 W), a 1.06-μm optical isolator and two 80-cm lengths of Nd^{3+}-doped, double-clad fiber. The 500-mW diode provides the pump for the seed source and the 3-W diode the pump for the amplifier. The output from the seed source is passed through the optical isolator and then coupled into the amplifying fiber. The isolator is necessary to prevent round-trip feedback from Rayleigh scattering in the amplifier section. A dichroic beamsplitter is used to separate the superfluorescent output from the amplifier pump light.



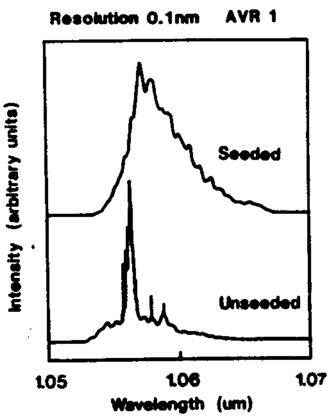
CFJ6 Fig. 1. Seeded power amplifier arrangement for Nd^{3+} superfluorescent fiber source.

Figure 2 shows the amplifier output power as a function of the 3-W diode drive current for an injected seed power of 7.5 mW. At maximum diode power, approximately 1.5 W launched, the device has an output power of 320 mW. Also shown is the output power at the amplifier pump end when the seed is switched off. Without the seed the amplifier section lases at output powers above 85 mW. It can be seen that the seeding technique results in a threefold increase in output power. The spectra at maximum pump power with and without the 7.5 mW seed is shown in Fig. 3 displaying clearly the suppression of lasing. The seeded device has a FWHM bandwidth of 4.5 nm centered at 1.058 μm.



CFJ6 Fig. 2. Output power of the superfluorescent source with and without the 7.5mW primary seeding source.

We have successfully overcome the problem of Rayleigh backscattering as a limiting factor on output power from fiber-based SF sources by seeding a high-power fiber amplifier with a second superfluorescent source of moderate power. An output power of 320 mW with a 4.5-nm bandwidth centered at 1.058 μm has been achieved. The device should have a significant impact in a number of sensor applications.



CFJ6 Fig. 3. Output spectra at maximum power with and without the seed source.

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