A novel fiber design using an annular Nd-doped laser waveguide for generating output powers in the 1-5 Watt range

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For many applications in telecommunication, sensing and spectroscopy reliable all-solid state laser light sources are desirable. The great variety on ionic species of the lanthanides with which the host material of fiber lasers may be doped enables to cover the spectral range between 0.9 and 3µm. Besides tunability a high output power is often desirable calling for an adaption of the fiber design on the beam parameter product of high power diode laser arrays used as pump sources. The recently developed double clad fibers |1| fulfil these demands. The extraction efficiency of this fibers is very high (>90%) but the absorption of the pump light is considerably low due to the unavoidable appearance of gallery modes. Decentred cores, periodical bending or mode scrambling |2| can improve this efficiency up to about 70%. In order to increase the output power and the absorption of the pump light we have chosen another fiber design which minimises the problems encountered with the gallery modes. The fiber consist of an undoped core of large diameter and a doped glass cladding surrounded by a coating. The refractive indices obey the relation $n_{clad}>n_{core}>>n_{coat}$. The refractive index/doping profile recommends to the designation M-profile fiber (MPF). Its design and construction data are given in Fig. 1a. Fig. 1b shows by a ray optics picture the pump- and laser light propagation. Moreover, it is shown that MPF's may be evanescently coupled because laser light guiding occurs near the surface of the structure through which the output power can be scaled up to even higher values. The optimum lengths for a double clad fiber and a MPF behave as 20:1. The pump power remaining in a 100 cm long MPF doped with 5000 ppm Nd_2O_3 is less than 5%. Output powers in excess of 1W with a slope efficiency of about 27% have been achieved, cf. Fig. 2.
We report on first experiments generating uniphase radiation from a stable (azimuthally) multimode beam and on the radiation properties of an evanescently coupled array of MPF's.
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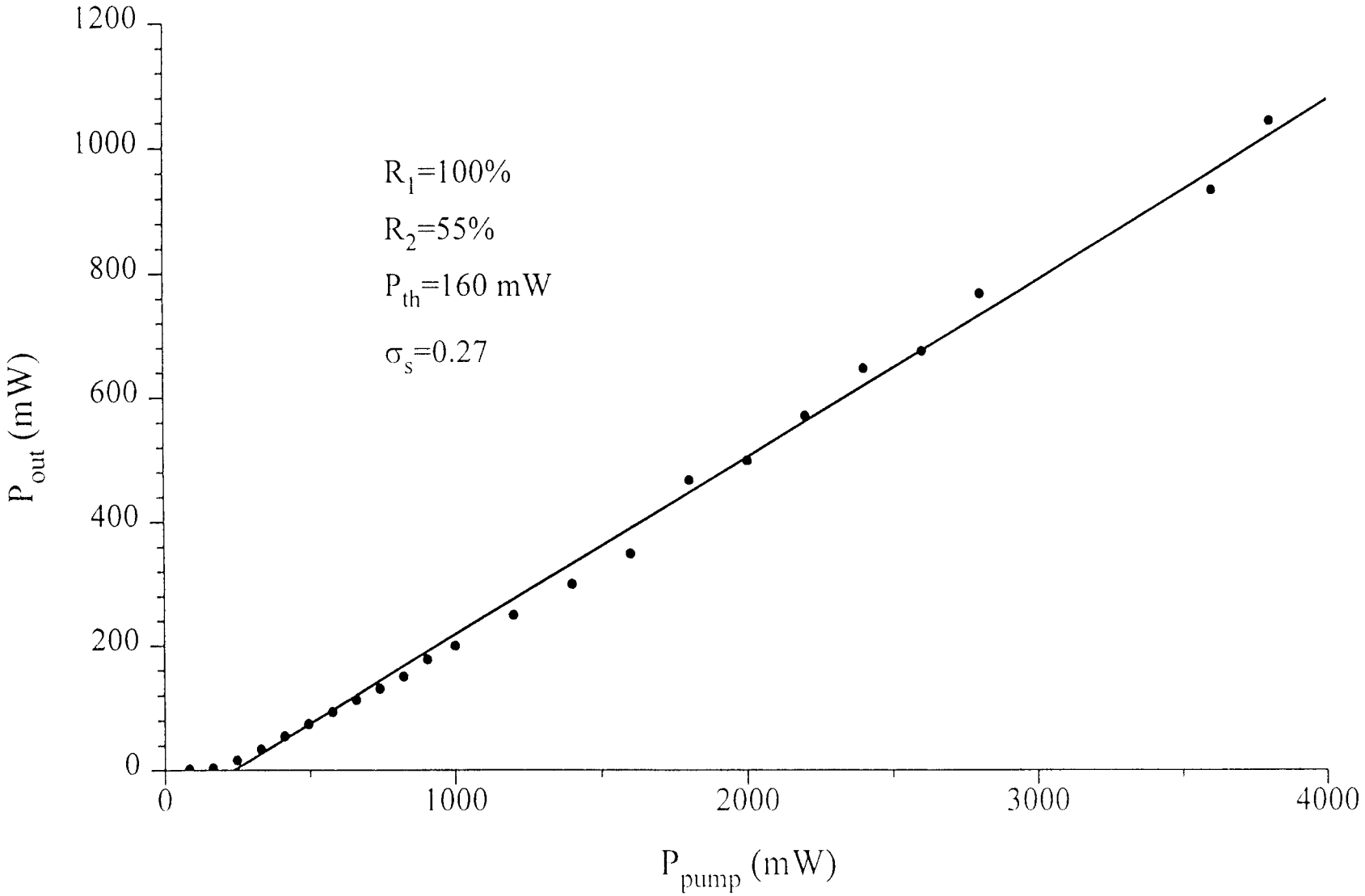
|2| H. Zellmer; U. Willamowski; A. Tünnermann; H. Welling; S. Unger; V. Reichel; H.R. Müller; P. Albers, Opt. Lett. 26(6), 578, 1995


1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
P_{out} (mW)
P_{pump} (mW)
R_1=100%
R_2=55%
P_{th}=160 mW
σ_s=0.27

M-profile fiber

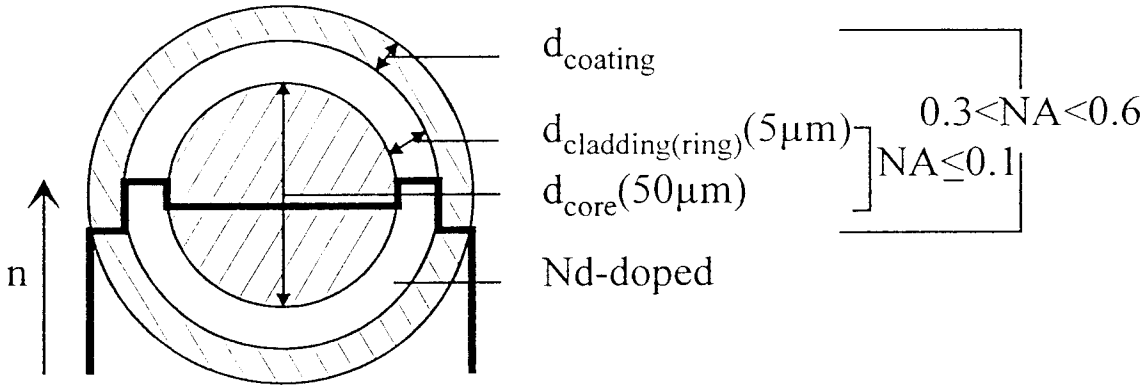


Fig. 1a