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High Gain Ultra-Short Length Phosphate Glass Erbium-Doped Fiber Amplifier Material

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Abstract

New short length optical amplifier designs take advantage of phosphate glass host material features such as high cross section, insignificant concentration quenching, and high solubility for rare earth ions. Recent erbium doped phosphate glass modeling and laboratory data support the prospect of a new class of ultra-short length amplifiers configurations and designs.

Summary

High gain short length erbium doped phosphate glass fibers and waveguides have demonstrated gain figures of 10dB to 27dB in 2.2cm to 8.8cm lengths [1,2,3,4,5,6,7].
Erbium doped phosphate glass amplifier computer modeling and laboratory performance data support the prospect of a new class of ultra-short length amplifiers configurations and designs. With doping levels of 6 to 12% (Wt.%) Er_2O_3, gains figures of ~ 20dB may be realized in gain lengths of less than 1cm. Figure 1 presents the results of ultra-short, fully saturated, erbium amplifier computer modeling.

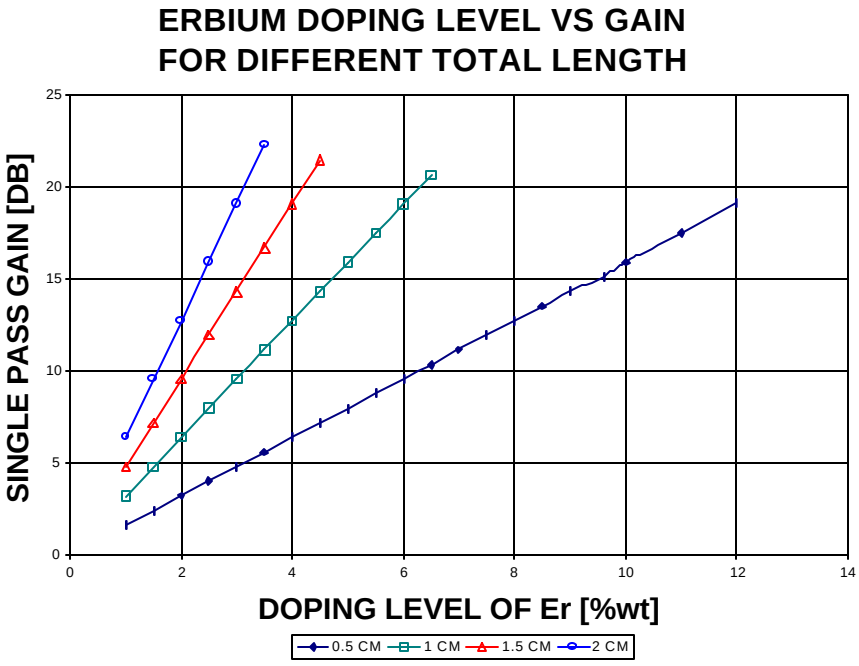

Fig. 1

Table 1 indicates the theoretical relationship between erbium dopant concentration, stored energy, and core diameter for a 1 cm length of QX/Er phosphate glass fiber.

Table 1.

Diameter (microns)	Length (cm)	Doping (%wt)	Er^{3+} Energy (mj)
8	1	6	0.036
20	1	6	0.22
50	1	6	1.39
100	1	6	5.57

At full saturation or 100% Er^{3+} ion $4I_{13/2}$ upper-state population inversion, the internal gain is estimated to be ~ 20-30dB. Testing and evaluation of ultra-short erbium phosphate glass amplifiers is initially accomplished with micro-disk and micro-chip multiple pass laser oscillators. This test bed is very similar to micro-disk lasers produced in other laboratories [8,9,10]. Advances in silica/phosphate fiber fusion splicing technology have allowed for more conventional test bed measurements of ultra-short fiber amplifier configurations. Additional short length fiber and waveguide amplifier performance data is also presented.

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