Fabrication and performance of Er-doped phase-separated alumino-silicate based optical fiber for fiber amplifier

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Abstract: Fabrication of Er-doped phase-separated SiO_2-Al_2O_3 glass based preform using conventional MCVD-SD technique is presented. The fiber developed exhibits better optical and spectral performance in C-band region compare to known silica-based counterpart.
OCIS codes: (060.0280) Fiber design and fabrication; (060.2690) Fiber Materials; (060.2410) Fibers, erbium; (060.2400) Fiber properties.

1. Introduction

The Erbium doped optical fiber amplifier (EDFA) is one of the key optical components in the present optical communication networks. To improve the performance of EDFA, like broadening of gain spectra, the effort is ongoing to develop next generation erbium doped fiber (EDF) by tailoring the glass host employing improved fabrication techniques. Although, different glass host (fluoride, telluride) other than silica can provide better performance, but considering compatibility with the present telecommunication system silica based glass is most suitable host.

Based on the above background, in this work, we present the fabrication and characterization of Erbium doped phase-separated alumino-silicate based optical fiber, which exhibits improved optical and spectral performance in the C-band region compared to other known silica-based glass optical fiber.

2. Experimental

A series of preform run has been carried out employing the modified chemical vapor deposition coupled with solution doping technique followed by appropriate thermal annealing to obtain Er-doped phase-separated alumino-silicate based optical preform with good core-clad boundary. The resin-coated fiber of dimension 245±2 µm was drawn from the fabricated preform. The field emission scanning electron microscopy (FESEM) along with the energy dispersive X-ray (EDX) were employed to evaluate the phase-separated nature inside the preform core [Fig. 1], while the electron probe micro analysis (EPMA) provided elemental distribution along the preform/fiber core. Extended X-ray absorption fine structure (EXFAS) analysis exclusively used to evaluate the environment surrounding the Er^{3+} ion and the different Al-ion coordination with change in the Al-ion concentration in soaking solution. Based on initial characterization results, different fabrication parameters were further fine tuned to improve the final fiber performance. Finally, the Er-ion life-time ($^4I_{13/2}$ to $^4I_{15/2}$ transition) and the optical gain of the fabricated EDFs was measured within the C-band (1530-1565 nm) in an EDFA gain measurement set-up. Our observed result establish that, the developed phase-separated alumino-silicate based EDF exhibit improved performance than that of non-phase separated alumino-silicate based EDFs with a gain excursion of 1.2 dB as presented in Fig. 2.

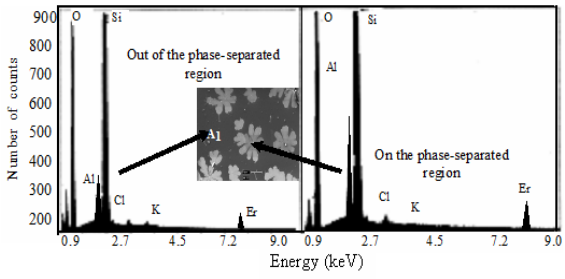

Fig.1 EDX curves in (right) and outside (left) the phase-separated region of alumino-silicate glass based Er_2O_3 doped preform with 4.5 mol% Al_2O_3

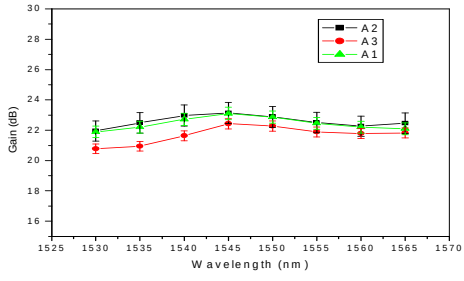

Fig.2 The optical gain curve of two phase-separated (A1 & A2) and non-phase separated (A3) EDFs at C-band under 0 dBm signal power using pump power of 400 mW

4. References

[1] I. A. Aksay and J. A. Psak, "Stable and metastable equilibria in the system SiO2-Al2O3" J. Am. Ceram. Soc. 58, 507-512 (1975).