Novel Polymer Optical-Fiber Based Lasers

Anuradha Rout*[a], V R Anand[b], Yuliya Semenova[a]

[a]Photonics Research Centre, Technological University Dublin , City campus, Grangegorman, Dublin, Ireland

[b]International School of Photonics, Cochin University of Science and Technology, Cochin-22, India

Introduction:

Polymer optical fibers (POFs) are very promising active materials for lasers and optical amplifiers due to their low manufacturing temperatures, flexibility and being good hosts for organic dopants, such as organic dyes or organic semiconductors. POF-based lasers offer narrow linewidths and low lasing thresholds making them attractive in a range of applications including optical sensing, illumination and optical communication networks.

Aim and objectives:

This PhD research is focused on the development of novel low-threshold, narrow-linewidth fiber lasers with tuning capabilities.

The main objectives are: 1) Explore the use of doped polymer fibers as active materials; 2) Investigate novel laser resonator structures including whispering gallery mode fiber loop, cylinder and microsphere resonators; 3) Demonstrate applications of the proposed laser structures in optical sensing.

POF fabrication steps:

- Preparation of mixture of methyl methacrylate, benzoyl peroxide (0.4 %wt.), n-butyl mercaptan (0.1 %wt.), Rh-B dye (10-5m/l), benzyl butyl phthalate (2 wt.%) and dimethyl sulfoxide (0.1 %wt.)
- The above mixture is filled in a 16 mm diameter glass tube (preform).
- The preform is placed in a silica oil bath for 72 hours at 70°C.
- Drawing of Rh-B doped POF from the preform in an optical fiber drawing tower at 170°C.

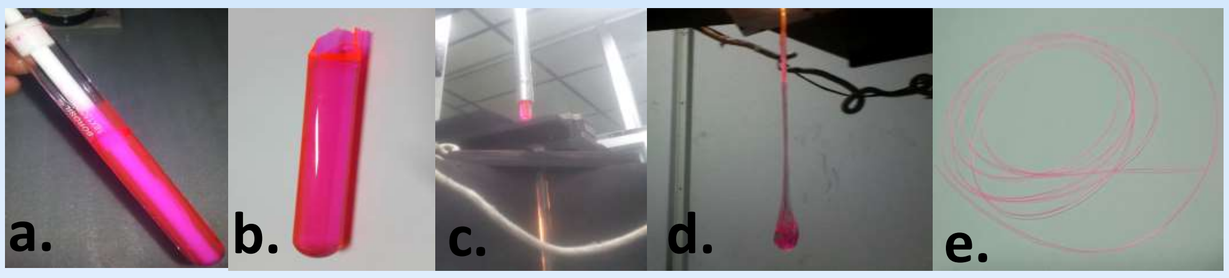

Fig. 1. (a) Controlled polymerization chain reaction, (b) Rh-doped polymer fiber preform; (c) optical fiber drawing tower, (d) fiber drawing process, (e) fabricated POF sample.

Characterization of fluorescence induced by side illumination of Rhodamine-B-doped POF

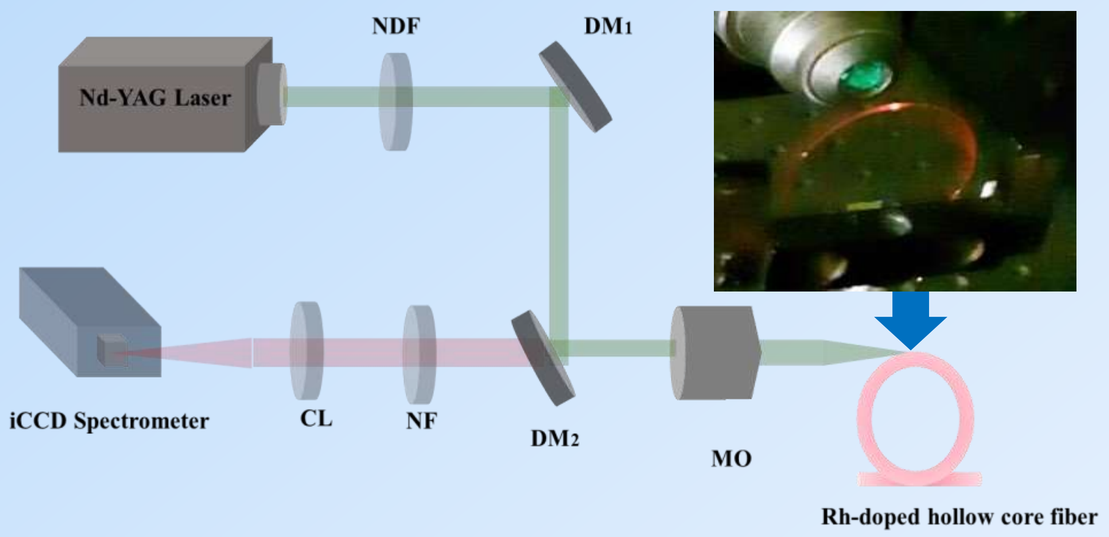

Fig 2. Experimental setup for characterization: Q-switched Nd-YAG Laser (8 ns, 10 Hz, 532 nm), NDF- Neutral density filter, DM1, DM2- Dichroic mirrors, NF- Notch filter, CL- Collective lens, MO- Microscopic objective, CCD Spectrometer.

Results and discussions

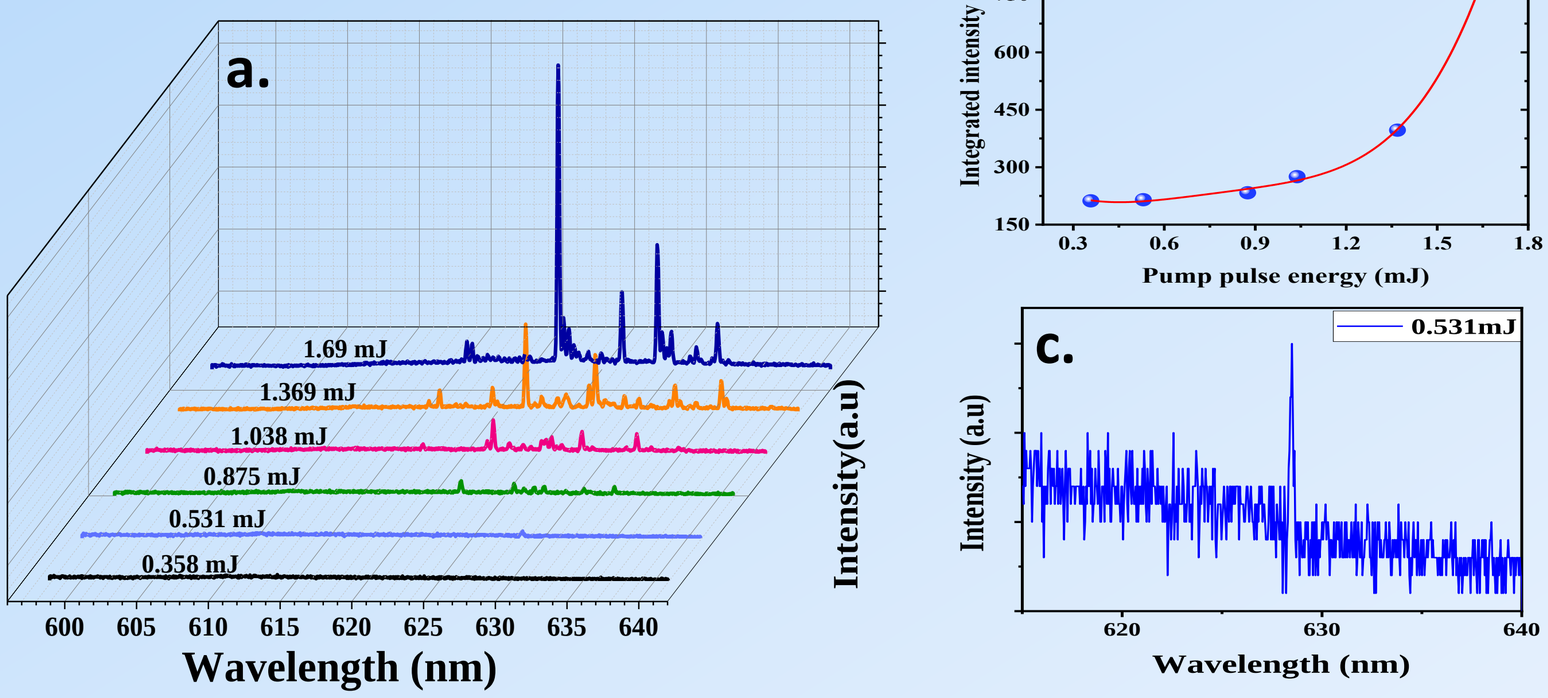

Fig. 3 (a) Fluorescent emission intensity spectra for different pump pulse energies (PPE); (b) emission intensity at 622 nm as a function of PPE; (c) spectrum near fluorescent emission peak (~628 nm) at threshold PPE.

Conclusions:

- Rh-B doped hollow-core POF samples were fabricated successfully.
- Fluorescence induced by side illumination of the fabricated Rh-B POF sample with a Q-switched Nd-YAG laser pump has been demonstrated experimentally.
- The dependency of the fluorescent emission intensity on PPE has been studied, a low lasing threshold of 1.5 mJ has been determined.
- Fabricated POF is a suitable active material for a laser resonator, studies are ongoing on the development of a laser resonator structure.