Directional random laser inside a large hollow-core fiber

R.J.R. Vieira, L. Gomes, N.U. Wetter
Instituto de Pesquisas Energéticas e Nucleares

C.J.S. de Matos
Universidade Presbiteriana Mackenzie

Arismar Cerqueira. S.Jr.
Universidade Estadual de Campinas - Unicamp

F. Couny, F. Benabid
University of Bath - Bath - UK

We demonstrate the use of a channel waveguide geometry consisting of a hollow-core photonic crystal fiber (HC-PCF) based on a large-pitch kagome lattice, in order to achieve a quasi-one-dimensional random laser (1D-RL) emission. The effective guiding property is demonstrated by a lower threshold of the high-gain scattering media inside the HC-PCF when compared with bulk emission inside a fluorescence cuvette.
The hollow-core was filled, by using a syringe, with a high-gain scattering medium composed of rhodamine 6G and ethylene glycol solution containing a colloidal suspension of 250 nm sized rutile (TiO_2) particles. The cladding air-filling fraction of PCF leads to a cladding effective index that is close to that of air and the fiber core refractive index, equal to the ethylene glycol refractive index, is $\sim$1.43, therefore, total internal reflection can guide light through the PCF. The fiber and the cuvette with the solution, dye molarity of 10^{-4} M and particle density of 10^8 cm^{-3}, were transversally pumped using a frequency doubled Nd:YAG laser (532 nm, 4 ns pulse width, 10 Hz repetition rate).
During the experiment, a strong and well collimated yellow ($\sim$570 nm) emission was visible. The spectral width of this emission decreased as a function of pump power. The threshold for the PCF laser was reduced by at least a factor 4 when compared to the same solution inside the cuvette. We conclude that the PCF allows a quasi 1D-RL provided by the two-dimensional confinement.