Nanocomposites and nanomaterials

Waveguide lasing of dye-doped nanoscale mesostructured films

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Lasers based on thin waveguide films are attractive for applications in optical communications. Increase of concentration barrier of quenching of the luminescence and create conditions for waveguide propagation of laser radiation in the film will be factors significantly influence the film luminescence efficiency and consequently the final laser performance. We have prepared dye-doped nanoscale sol-gel films used network-forming oxides such as silica or titania. The possibility of controlling dye locations allowed increasing its concentration several orders compared to conventional dye lasers without reducing the quantum yield of luminescence. Another problem was solved by the use of titanium dioxide matrix (n~1.68), that exceeds index of glass substrate, ~~so~~ to form asymmetric planar waveguides. Under pumping by the beam (λ=532 nm) focused in the strip 18x0.1mm^2, radiation of the both films consisted of the central beam with high divergence coming out of the end of the excited track and two symmetrical side beams coming out of his side surfaces at an angle 30^o to the track. These beams form symmetrical bands on the screen, the shape of which depends on the refractive index of the films. When pumping intensity exceeds above a certain threshold the radiation spectrum on an axis of the central beam narrows sharply (up to 4 nm) and shows weak equidistant spectral lines. The spectrum extended in the peripheral part of the beam and the lines became weaker. The spectrum of lateral beams under the same pumping narrows substantially less contains no lines and its shape is close to the spectrum of the peripheral part of the central beam.

Thus, for both films, we observed lasing, which appears as radiation of the central beam that consists from enhanced luminescence (along with track) and lasing that occurring due to the distributed feedback grating of enhancement created by the oncoming waves of the enhanced luminescence. Two order reducing the threshold pump intensity and changing the shape of lateral beams under changing TiO_2 matrix instead SiO_2 one is evidence of formation the waveguide amplifier in the TiO_2 film. The 30^o orientation of lateral beams is confirmed their belonging to the leaky modes. These results show possibility high-quality lasing on the basic mode of a waveguide that forms the central beam.