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Peculiarities of forced radiation formation in thin dyed hybrid organic-inorganic films

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The development of integrated optoelectronics requires the creation of lasers with minimum sizes which would be acceptable for integration into the corresponding optoelectronic circuits. The most suitable for this purpose are waveguide planar lasers, which are integrated with waveguides and other devices of the optoelectronic circuit. At present, most attention is paid to films based on rare earth ions in glass and crystal matrices and lasing dyes in polymers with a refractive index in the range from 1.3 to 1.6.

We have investigated the features of the occurrence of Rhodamine 6G stimulated emission in hybrid organic-inorganic films (Pluronic 123 + TiO2 or SiO2) with a minimum thickness close to the critical value of the waveguide mode. The inorganic component of the film provided a variation of the refractive index in the range of 1.49 - 1.565, while the organic component allowed the introduction of a dye of high (up to several mmol/l) concentration. The films were placed on the glass substrate by dipping (deep coating) and spin coating technique, which made it possible to obtain films with thicknesses greater and less than the critical one, respectively. The pumping was performed by the second harmonic of the YAG:Nd3+ laser.

When the threshold pumping intensity of 0.14 MW/mm² was exceeded in TiO2-based films with a thickness of 340 nm by 10% above the critical value (300 nm), a rapid narrowing of the radiation spectrum from 60 to 5 nm and the appearance of a directed coherent beam with an angular divergence of 6.3° were observed. The beam had a pronounced interference structure on the side of the substrate, indicating that a part of the beam penetrated it. The small divergence compared to the diffraction divergence at the film end confirms that the radiation formation is influenced by the substrate, which is thicker (1 mm). The formation of interference strips can be associated with the emergence of Lummer-Herke modes, which are formed when radiation partially penetrates into the substrate when incident on it at an angle slightly less than the critical one. At thicknesses less than the critical one, no such effects occurred.

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