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QWH3

Laser beam self-channeling in a photorefractive waveguide caused by fanning effect

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Recently we have reported an experimental observation of the light beam self-channeling inside the photorefractive $Bi_{12}TiO_{20}$ waveguide-like sample.[1] An illumination of the photorefractive waveguide by the pump beam with uniform intensity results in the intensity redistribution at the waveguide output. The phenomenon occurs when the strong fanning effect takes place.

In this presentation we discuss a theoretical model, which consider the light energy flow from the pump beam to the fanning beam and backward after the fanning beam reflection. The main reason of the intensity redistribution is total internal reflections of fanning beams from waveguide surfaces and following simultaneous beam coupling of the pump beam, the fanned light, and the internally reflected fanned light. We provided a numerical simulation of this effect by solving the system of coupled wave equations for the crystal limited by two surfaces. As an example, Fig.1 shows calculated intensity distribution inside the photorefractive plane $Bi_{12}TiO_{20}$ waveguide, which length is 36 mm and width is 0.5 mm. The incident intensity of the pump beam is normalized to one. Both exrternal electric field influence and natural optical activity were taken into account.

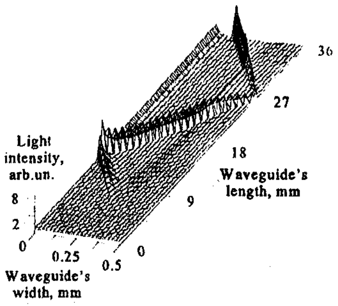

Fig.1. Calculated intensity distribution in a photorefractive plane waveguide.

Experiments have been carried out with $Bi_{12}TiO_{20}$ waveguide-like crystal under an alternating bipolar electric field of square wave form. Strong dependence of the intensity redistribution on the pump beam polarization state has been observed, which can be attributed with the electrooptic coefficients anisotropy. Our model qualitatively explains experimentally observed intensity redistribution. Theoretical analysis shows that reflections of fanning beams from both waveguide surfaces are responsible for strong intensity redistribution and the photorefractive surface wave can be generated in the photorefractive waveguide, which possess smaller coupling coefficients than it needed for a bulk sample.

Reference

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QWH4

Optical limiting and multistability in a nonlinear fiber ring including stimulated Raman scattering

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Owing to their intriguing nonlinear dynamics, synchronously driven fiber cavities have attracted growing attention these last few years. They can be found in practices as the basic elements of several fiber-based devices such as APM lasers [1], Raman lasers [2] and fiber loop memories [3]. Although they are conceptually simple devices, synchronously driven cavities exhibit complex dynamical behaviors. In this work we analyze the influence of Raman scattering on the dynamics of synchronously driven cavities. We show, in particular, that Raman scattering is responsible for optical limiting action and a new type of optical multistability.

We deal with fiber cavities of high finesse for both the pump and Stokes waves. Therefore, unlike conventional fiber Raman laser configurations, we consider strong pump recirculation. This recirculation is assumed to be coherent so that it can lead to high power confinement and allows for shorter fiber lengths. We treated this problem by means of full numerical simulations of the propagation equations and cavity boundary conditions as well as by means of a mean-field approach. Both models agree well. The mean-field model allows for analytical treatments of the cw regime. This provides simple and thorough physical insights into this complex dynamical problem. Response curves for both the pump and Stokes waves are given in terms of symple polynomial expressions. Fig. 1 shows a typical example of response curves. We see that the system exhibits optical bistability in the vecinity of the lasing threshold. Above threshold, the pump field undergoes optical limiting in a way somewhat akin to the behavior of the doubly resonant optical parametric oscillator [4]. Note the low lasing thresholds (with minimum values of tenths of mW) obtained thanks to pump recirculation. We have investigated the possibility to use the device as a low threshold tunable pulsed Raman laser. Promising results have been obtained using nanosecond pulses and dispersion tuning technique for wavelength selection.

References:

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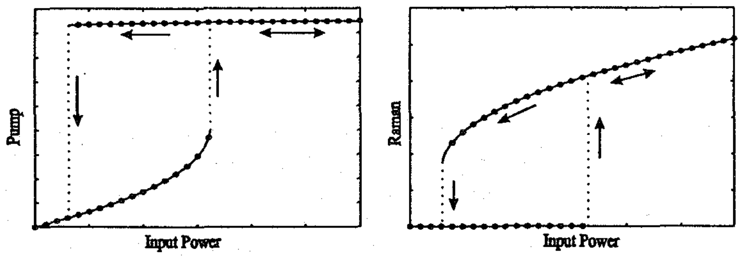

Figure 1: Pump and Raman response curves for cw (solid line) and pulsed (dots) excitation. The physical parameters are: fiber loop lenght of 10 m, $D = \pm 5$ ps/(km nm) for Raman and pump waves near zero-dispersion, cavity losses $\theta^2 = 0.05$, normalized pump detuning $\Delta = 6$ and nanosecond input pulses. The input threshold for Raman lasing in this case is 400 mW and the corresponding Stokes intensity in the cavity of 530 mW