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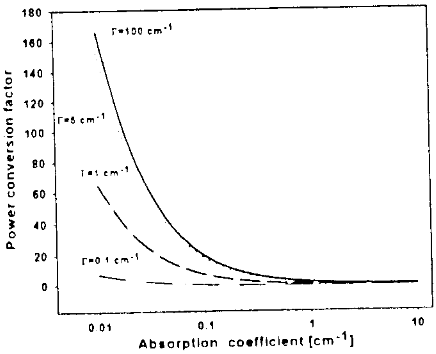
Conditions for efficient build-up of power in a ring-cavity with $Rh:BaTiO_3$

Małgosia Kaczmarek
Department of Physics, University of Exeter, Exeter EX4 4 QL, United Kingdom
tel 01392 264139, fax 01392 264111, e-mail M.Kaczmarek@exeter.ac.uk

Robert W Eason
Optoelectronics Research Centre and Department of Physics and Astronomy,
University of Southampton, Southampton SO17 1BJ, United Kingdom
tel: 01703 592098, fax: 01703 593142, e-mail: rwe@orc.soton.ac.uk

Numerous interaction geometries have been developed for photorefractive materials that rely on amplification of light via the two-beam coupling effect. One of the most elegant and simple configurations is a unidirectional ring resonator, which consists of a photorefractive crystal placed in a ring cavity and pumped by an external beam [1]. If the two-beam coupling gain is above threshold, the resonating beam will build up from the amplification of scattered light.

We present results on the most crucial parameters for the effective build-up of power in the resonating beam: the wavelength of the pump beam, and the type of photorefractive material. The resonating beam accumulates energy from successive amplification in a photorefractive material until saturation sets in, but also loses energy from absorption and other losses such as Fresnel reflections from the crystal, and imperfect mirrors. We have performed intensity-dependent modelling of the resonator's power conversion factor. The power conversion factor is defined as the ratio of the resonating beam intensity to the intensity of the external pump beam. The figure below shows the dependence of this factor on absorption coefficient for different values of coupling coefficient Γ.



Power conversion inside a ring resonator

The most interesting result of this example is that a high intensity resonating beam can build-up, even for modest coupling coefficients (above $\Gamma=5\ cm^{-1}$), provided that absorption is, simultaneously, low (below $0.1\ cm^{-1}$). It is, therefore, crucial to keep the value of absorption to a minimum and, at the same time, trying to achieve, at least moderate two-beam coupling coefficient. The values of these two coefficients can be varied, to a certain extent, by a careful selection of the external pump wavelength. We found that the optimum values of these coefficient can be fulfilled in a $Rh:BaTiO_3$ crystal. For example, the original 'blue' sample of $Rh:BaTiO_3$ had low absorption ($0.06\ cm^{-1}$) but relatively high coupling coefficient ($11.2\ cm^{-1}$) at 1.06 μm. Similar, promising parameters of coupling coefficient and absorption have been found in other samples of Rh:BaTiO3 [2].

In order to select the most appropriate type of $Rh:BaTiO_3$ we have investigated several samples of this crystal, doped with different amount of rhodium - 400 ppm, 24000 ppm, 3200 and 5000 ppm - and processed in different conditions. We have been particularly interested in determining the magnitude of two-beam coupling coefficient in these samples and also determining the value of intensity dependent change of absorption. We will present the experimental results showing that all samples of Rh:BaTiO3 we studied show increased absorption at high light intensities at 1.06 μm - an important factor for the efficient build-up of power in a ring resonator.

References:

[1] J. O. White, M. Cronin-Golomb, B. Fischer, A. Yariv, Appl. Phys. Lett. 40, 450 (1982).

[2] N. Huot, J. M. C. Jonathan, G. Pauliat, D. Rytz, G. Roosen, Opt. Comm. **135**, 133 (1997).