total-internal-reflection SPPC (Cat mirror). We obtained high SPPC reflectivities in a large incident angle range in 0°-cut and 45°-cut crystals. Even if the incident angles are negative, SPPC wave still has high reflectivity which can be observed only in Ce:$BaTiO_3$ to our knowledge. The dependence of SPPC reflectivity on the different wavelengths has been studied. Over 50% SPPC reflectivities with the wavelengths ranging from 488 nm to 780 nm are obtained. The reflectivities of 85%, 86.8% and 77% were achieved at $\lambda = 730$ nm, $\lambda = 633$ nm and $\lambda = 515$ nm, respectively. We also studied the SPPC reflectivities as a function of the position X of the incident laser beam upon the crystal entrance face (100). It indicates that the SPPC reflectivities are larger than 60%, while the position X is shifted in a range of 5 mm (from 2 mm to 7 mm) along the c direction (8 mm). Thus the SPPC reflectivity is highly insensitive to incident beam's angle, inclination, and pitch relative to the crystal. This makes obtainment of the SPPC wave easy. Fidelity of phase conjugate image by backward stimulated photorefractive scattering without and with an aberrator has comparable resolution, as such 313 line pairs/mm. Coupling constant of two-wave mixing is larger than 40 cm^{-1}. Estimated photorefractive charge densities ranged from 1 ~ 2 × 10^{17} cm^{-3}. The Electro-Optic coefficients r_{42} and r_{13} in Ce: $BaTiO_3$ crystals are one and a half as high as undoped $BaTiO_3$ crystal. Thus, this crystal is more attractive for use in practical devices and applications.

The $BaTiO_3$ crystal lattice constants in differently doped-cerium concentrations were precisely measured by X-ray. Increase of lattice volume with increasing doping cerium concentration was observed. For this reason it is deduced that the cerium is substituted for titanium.

We proposed a new model that explained theoretically the experimental date well.

TuE2 **930**

High-gain beam amplification and phase conjugation at red and near infrared wavelengths in 'blue' $BaTiO_3$:Rh

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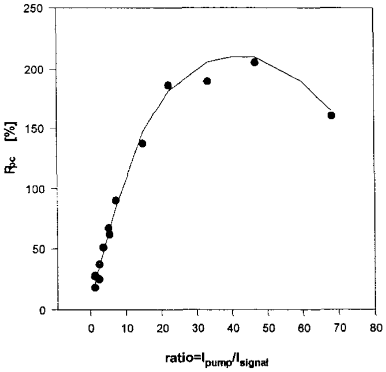
'Blue' $BaTiO_3$:Rh shows a high infrared and red sensitivity.[1,2] Our earlier studies of this new type of photorefractive crystal revealed strong intensity-dependent effects, namely light-induced absorption and transparency. These phenomena have been successfully modelled by incorporating secondary photorefractive centres into the band-gap model.[3,4]

We also investigated the performance of blue $BaTiO_3$ as a phase conjugator and obtained high reflectivities in the self-pumped phase conjugation configuration. In the wavelength range 720–835 nm reflectivities of 62% were achieved, and in the range 855–1004 nm reflectivities of up to 76% were observed.[5]

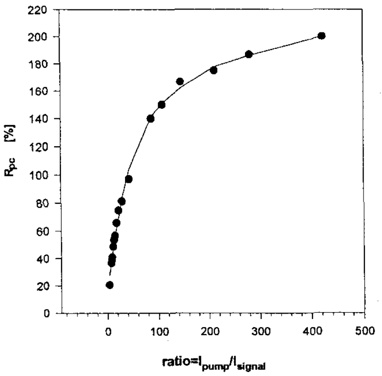
In this contribution we present further experimental studies of wave mixing in this new type of $BaTiO_3$. Our work was aimed, firstly, at measuring the maximum gain obtainable in two-beam coupling arrangements. The measurements were done at near infrared wavelengths (730 and 800 nm) using a Ti:Sapphire laser pumped by an Ar$^+$ laser, and in visible using the 647 nm line of a krypton laser. Very large values of gain, as high as 11 000, were experienced by the signal beam at 647 nm. It should be noted that this value, one of the highest two-beam coupling gains reported so far, was achieved without any need for suppressing the beam fanning. The two-beam coupling results obtained at 800 nm showed a smaller gain, of approximately 150. However, the magnitude of coupling coefficient which can be reduced from this gain, namely 17 cm^{-17}, is quite significant for the beam coupling of infrared wavelengths in $BaTiO_3$.

Secondly, we have studied coupling between mutually incoherent beams via double-phase conjugation (DPCM), and double-colour pumped oscillations (DCPO). In both of these configurations, the interaction between two mutually incoherent input beams of either the same (DPCM) or different wavelengths (DCPO) gives rise to simultaneous self-generation of two new waves. Using infrared wavelengths (730–810 nm) from a Ti:Sapphire laser, we have obtained the double phase conjugation effect, for the first time in blue $BaTiO_3$, and measured its maximum phase conjugate reflectivities as well as the optimum geometry. A strong photorefractive response allowed self-pumped phase conjugation to be initiated together with the double-phase conjugation process, and competition between the two phenomena was observed. Particular care was necessary to avoid generating the self-pumped phase conjugate beam during the measurement of DPCM reflectivities. We found that the maximum DPCM reflectivities (up to 200%) were obtained for 760 nm (Figure 1). Lower values of reflectivities (up to 90%) were observed for other infrared wavelengths, namely 730, 800 and 810 nm.

Further, in order to investigate the full potential of blue $BaTiO_3$ and its sensitivity to both visible and infrared wavelengths, we set up the double-colour pumped oscillator arrangement. For the two input beams we used the 647 nm output of a Kr$^+$ laser and the 800 nm output of a Ti:Sapphire laser. A reflectivity of 200% for the infrared oscillation beam was achieved (Figure 2). To our knowledge, this is the first demonstration of DCPO between visible and infrared radiation. The efficient transfer of energy between these two very different wavelengths can be accompanied by a transfer of spatial information between visible and infrared.



TuE2 Fig. 1. Double phase conjugate reflectivity at 760 nm in Rh:doped blue $BaTiO_3$.



TuE2 Fig. 2. Reflectivity of double-colour pumped oscillator with 647 and 800 nm in Rh: doped blue $BaTiO_3$.

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TuE3 **945**

Fabrication of zone plate hologram using field-associated etching technique

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Hologram microlens are becoming standard optical components with current applications in optical communications, optical computing and optoelectronic integrated circuits (OEICs). The fabrication