9:00am

CFC4 Impurity enhanced self-pumped phase conjugation at near infrared wavelengths using "blue" $BaTiO_3$

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With the availability of laser diodes operating at near infrared wavelengths, attention has recently been drawn to the possibility of extending the response of photorefractive crystals from the visible region of the spectrum out to longer wavelengths. This would then allow observation of photorefractive processes, such as self-pumped phase conjugation (SPPC), using modest powers at wavelengths compatible with solid-state lasers.

Recent work with $BaTiO_3$ has indicated that the presence of impurities (such as cobalt[1]) can enhance crystal response at near infrared wavelengths. We present results of experiments using a new impurity inclusion in $BaTiO_3$, which resulted in enhanced absorption at near infrared wavelengths (Fig. 1). An absorption peak at 640 nm gave the crystal a blue color. The crystal sample had dimensions 4.70 × 2.69 × 4.41 mm^3 with the c-axis parallel to the 4.41 mm side and was mounted in air and at room temperature with no external applied electric field. Assessment of SPPC behavior was carried out between 720 nm and 1004 nm using a Ti:sapphire laser with the beam e-polarized and incident on the 2.69 × 4.41 mm^2 crystal face. SPPC was observed out to 1004 nm with an optimized reflectivity of 76% (Fig. 2) with the crystal placed at Brewster's angle to the incident beam to both minimize the Fresnel reflection and maximize access to the largest electro-optic coefficient. Using the same geometry, SPPC reflectivities of up to 38% were recorded at 1.064 μm using a diode-pumped Nd:YAG laser. Measurement of response time against incident beam power was performed using the Ti:sapphire tuned to 800 nm and optically isolated. A response time proportional to I^{-x} where x = 0.75 was observed (Fig. 3).

If we assume the CAT (corner reflection) mechanism,[2] and a round-trip path length of 1 cm for the beam traveling from the crystal entrance face to the TIR corner, then the absorption coefficient of $\alpha \sim 1.4\ cm^{-1}$ (from Fig. 1) at 800 nm would imply that the maximum reflectivity possible at that wavelength is $e^{-1.4} = 0.25$, i.e., 25% — more than a factor of 2 less than the measured (and unoptimized) reflectivity of 56%. Given the high crystal absorption, it seems unlikely that the CAT geometry can alone account for the high SPPC reflectivity experimentally observed. We believe that, in the absence of significant light-induced transparency, reflection gratings near the entrance face of the crystal may be responsible for this phenomenon because of a backward scattering process.[3]

We also present data that suggest that it may be possible to remove instabilities in the phase conjugate reflectivity by vibrating the crystal, and we examine this behavior as a function of frequency and amplitude of oscillation.

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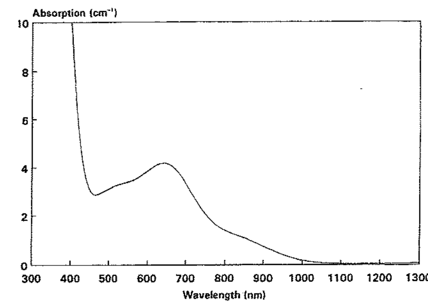
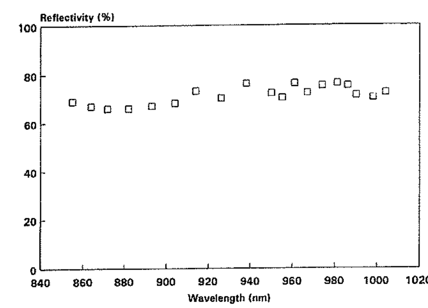
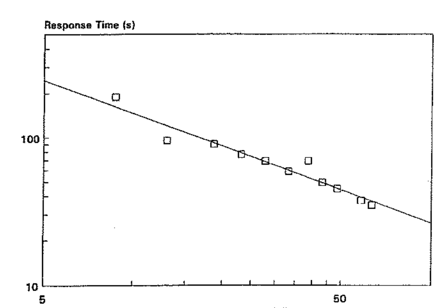


CFC4 Fig. 1. Absorption spectrum of the "blue" $BaTiO_3$ using randomly polarized light perpendicular to the crystal c-axis.



CFC4 Fig. 2. Graph of phase conjugate reflectivity against wavelength.



CFC4 Fig. 3. Graph of SPPC response time against incident power (I_{in}). The straight-line fit indicates an I_{in}^{-x} power law with x = 0.75. Note that 10mW incident power corresponds to 0.64 Wcm^{-2}.