PHOTOVOLTAIC INDUCED GRATING INSTABILITIES (Preprint)
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FEBRUARY 2006
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PHOTOVOLTAIC INDUCED GRATING INSTABILITIES (Preprint)

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### 14. ABSTRACT
- The PV field is responsible for undesirable grating recording noise, or spikes in transmitted power.
- Corresponding spikes in the transmission of light incident at the Bragg angle indicate the grating is partially destroyed rather than momentarily dephased.
- The noise is most likely due to a sudden strong current and/or avalanche current flow through the bulk crystal, such that the $E_{\infty}$ is randomized and the grating is partially destroyed.

### 15. SUBJECT TERMS
Photovoltaic Induced Grating, Two-Beam Coupling, Contra-Directional Coupling
Photovoltaic Induced Grating Instabilities

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Outline

• Motivation

• Experimental Setup

• Experimental Results in Congruent LiNbO₃:Fe

• Conclusions
Motivation

Evans et al., "Understanding and eliminating photovoltaic induced instabilities in contra-directional two-beam coupling in photorefractive LiNbO$_3$:Fe," Optical Materials, in press.


Two-beam coupling in LiNbO$_3$:Fe

Contra-Directional Coupling:
- Good spatial overlap of focused beams
- Decreased recording time
- Minimizes the grating spacing
- Maximizes the diffusion field
- Needs high trap density

\[ m \Lambda = 2 \delta \sin \theta \]

\[ E_{D} = \frac{2 \pi k_{B} T}{\epsilon \Lambda} \quad \Lambda_{opt} = 2 \pi \frac{k_{B} T}{\epsilon^{2} N_{\Lambda}} \]

The space charge field is increased because \( \Lambda \) approaches \( \Lambda_{opt} \) in LiNbO$_3$. 

\[ E_{0} = -\left( E_{0} + i E_{d} + E_{p} \right) m(z) \]

\[ 1 + \frac{E_{0}}{E_{q}} - i \frac{E_{0}}{E_{q}} N_{d} E_{pf} \]

Time (s)

Power (arb. units)
Effect of two-beam coupling in Region B

Two-beam coupling noise

The sudden burst of light through the crystal indicates almost complete "loss" of the grating

This could be due to:

1) a sudden strong current and/or avalanche current flow through the bulk crystal, such that the $E_{ac}$ is randomized and the grating is partially destroyed

OR 2) the build-up of $E_o$ causes the grating to become dephased

OR 3) momentary partial domain reversal - No change in gain direction
Experimental Setup

- Measuring the light transmitted through the crystal for both lines.
- Low power at Bragg angle to prevent an additional grating.
- A filter on Detector B blocks any scattered light from the 532 nm line.

Results
Experimental Setup
(Cylindrical Lens)

If the grating is dephased, the Bragg angle will change and there will be a shift in the reflected light.

Results
(Cylindrical Lens)

![Graph showing power vs. time for Detector A and Detector B]
Conclusion

- The PV field is responsible for undesirable grating recording noise, or spikes in transmitted power.

- Corresponding spikes in the transmission of light incident at the Bragg angle indicate the grating is partially destroyed rather than momentarily dephased.

- The noise is most likely due to a sudden strong current and/or avalanche current flow through the bulk crystal, such that the $E_{sc}$ is randomized and the grating is partially destroyed.

Evans et al., "Understanding and eliminating photovoltaic induced instabilities in contra-directional two-beam coupling in photorefractive LiNbO$_3$:Fe," Optical Materials, in press.