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**PHOTOVOLTAIC INDUCED GRATING
INSTABILITIES (Preprint)**

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**Agile Filters Project, Exploratory Development
Hardened Materials Branch**

FEBRUARY 2006

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14. ABSTRACT <ul style="list-style-type: none"> • 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. 					
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Photovoltaic Induced Grating Instabilities



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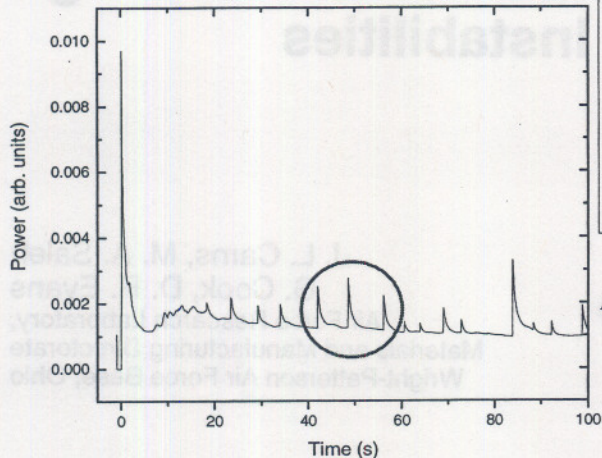
Outline



- Motivation
- Experimental Setup
- Experimental Results in Congruent $\text{LiNbO}_3:\text{Fe}$
- Conclusions



Motivation



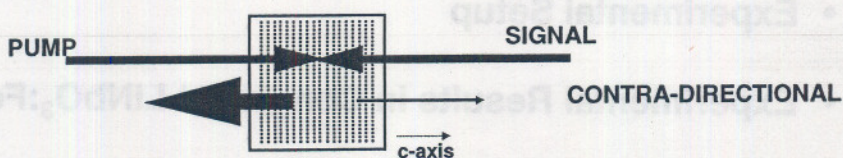
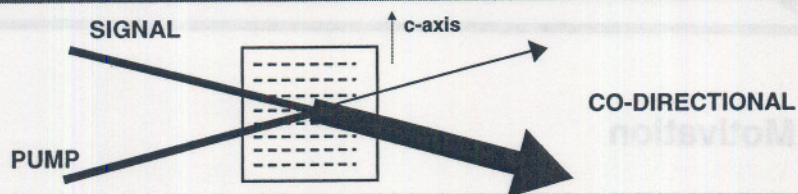
$$E_{sc}(z) = \frac{-(E_0 + iE_d + E_{pv})m(z)}{1 + \frac{E_d}{E_q} - i\left(\frac{E_0}{E_q} + \frac{N_a E_{pv}}{N_d E_q}\right)}$$

Evans et al., "Understanding and eliminating photovoltaic induced instabilities in contra-directional two-beam coupling in photorefractive LiNbO₃:Fe," Optical Materials, in press.

Evans et al., "Elimination of Photorefractive Grating Writing Instabilities in Iron-doped Lithium Niobate," IEEE J. Quant Elect., 38, 1661 (2002).



Two-beam coupling in LiNbO₃: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

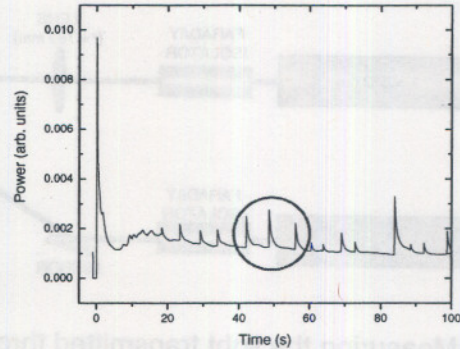
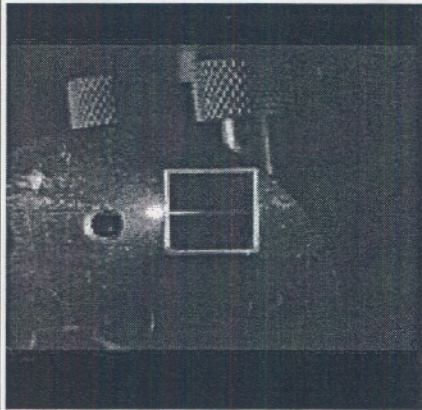
$$m\lambda = 2d\sin\theta$$

$$E_D = \frac{2\pi k_b T}{e\Lambda} \quad \Lambda_{opt} = 2\pi \sqrt{\frac{\epsilon_s k_b T}{e^2 N_A}}$$

The space charge field is increased because Λ approaches Λ_{opt} in LiNbO₃



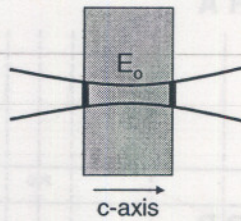
Effect of two-beam coupling in Region B



Two-beam coupling noise



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



This could be due to:

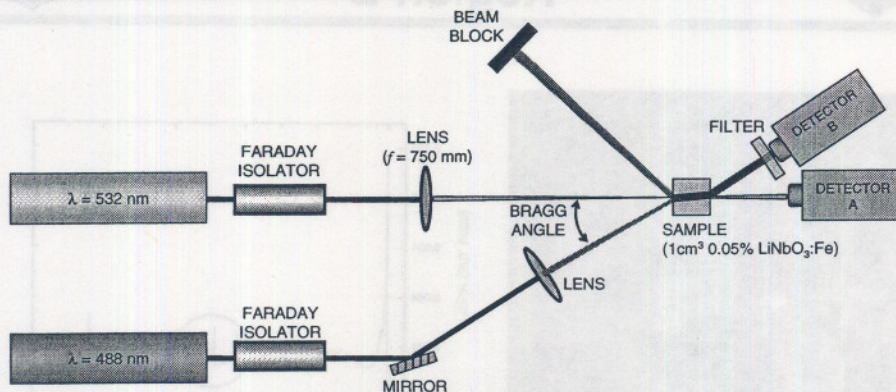
1) a sudden strong current and/or avalanche current flow through the bulk crystal, such that the E_{sc} is randomized and the grating is partially destroyed

OR 2) the build-up of E_0 causes the grating to become dephased

~~OR 3) momentary partial domain reversal~~ No change in gain direction



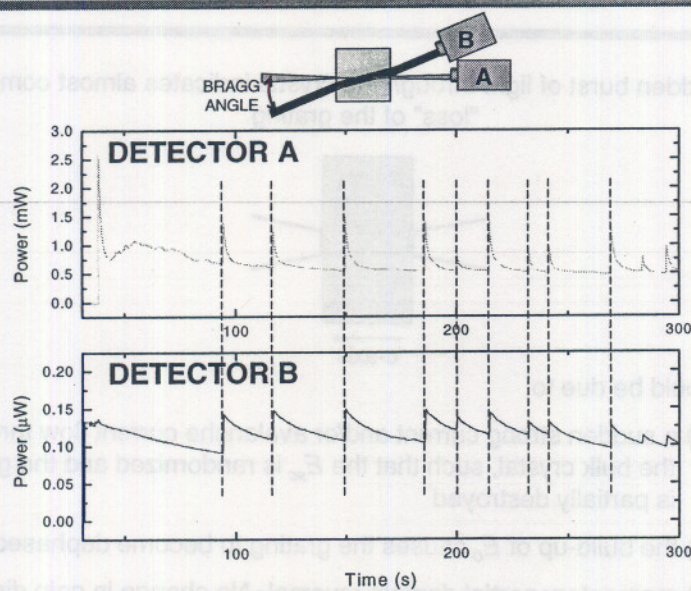
Experimental Setup



- 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.

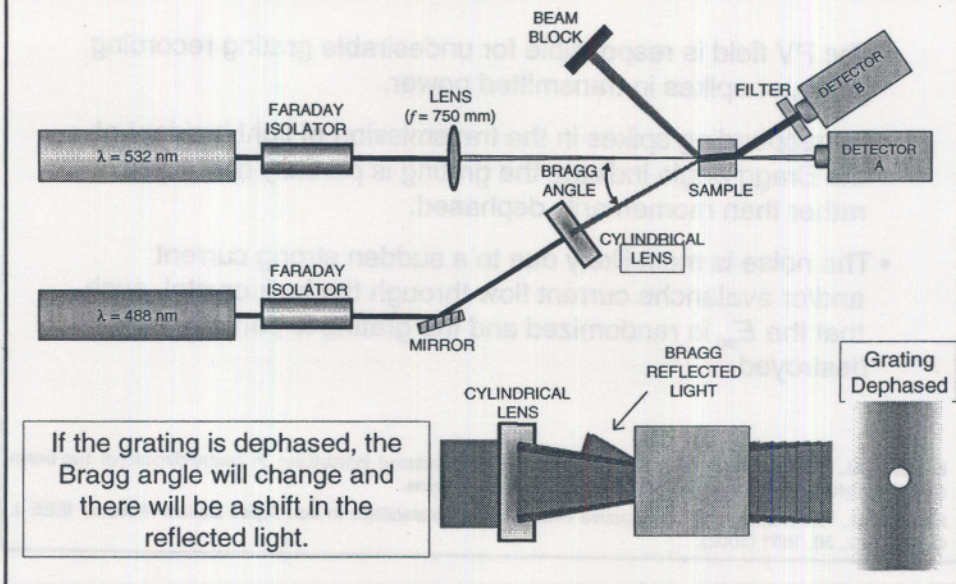


Results

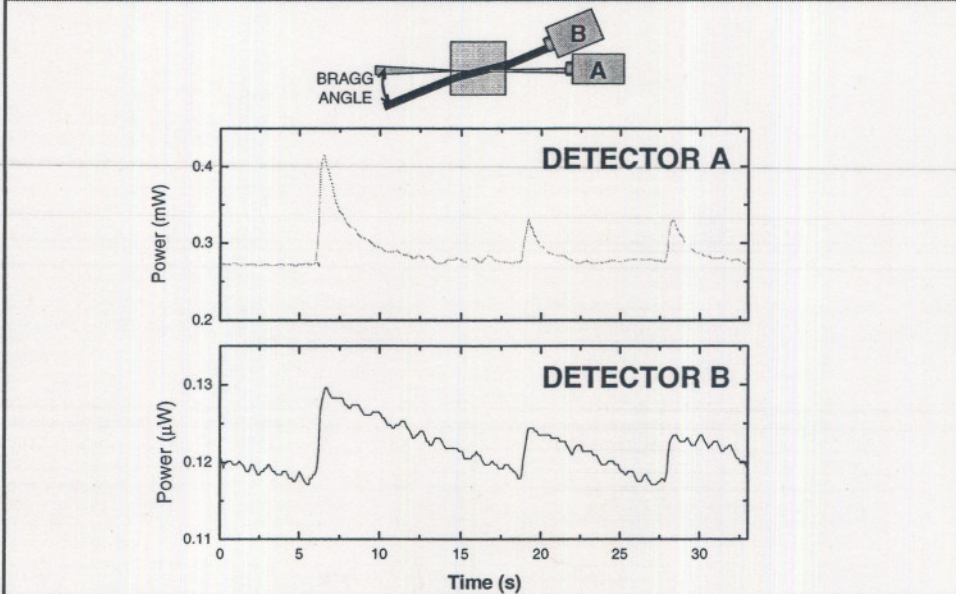




Experimental Setup (Cylindrical Lens)



Results (Cylindrical Lens)





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.

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