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Double-Dynamic Interferometry in IR and Visible in Semiconductor Crystals

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Double-Dynamic Interferometry in IR and Visible in Semiconductor Crystals



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ABSTRACT

We introduce a compact single-beam wave-front division interferometer, without stabilization for real-world applications. Using a 15 mW CW HeNe laser, we reflect a laser beam onto a mirror, which is connected to a function generator, that allow controlled phase modulation of the laser beam that illuminates the semiconducting crystal CdTe and ferroelectric crystal Sn2P2S6 (SPS).

THEORETICAL MODEL

$$\frac{\partial N^+}{\partial t} = SI(N - N^+) - rnN^+$$

$$\epsilon\epsilon_0 \frac{\partial E}{\partial t} + e\mu mE + eD\nabla n = J$$

$$\nabla \cdot (\epsilon\epsilon_0 \vec{E}) = e(N^+ - N_A - n)$$

- Basic equations simplify for the case of small contrast interference pattern:

$$I(x, t) = I_0 \left\{ 1 + \left[\frac{m}{2} \exp(ikx - i\Omega t) + c.c. \right] \right\}$$

- m is the modulation index (intensity contrast).
- k is the grating vector.
- I_0 is the average spatial intensity.
- Ω is the frequency detuning between laser beams.

- n is the electron concentration
- N is the photosensitive ionized centers fixed in space
- E is the electric field
- e is the effective charge of the carrier
- μ is the mobility
- D is the diffusion coefficient of the mobile carriers
- N_0 is the total concentration of photosensitive centers
- N_A is the concentration of the compensating centers (acceptors)
- g is the optical generation rate
- β is the thermal generation rate
- r is the recombination coefficient,
- ϵ_0 is the dielectric permittivity of vacuum
- ϵ is the relative dielectric constant.

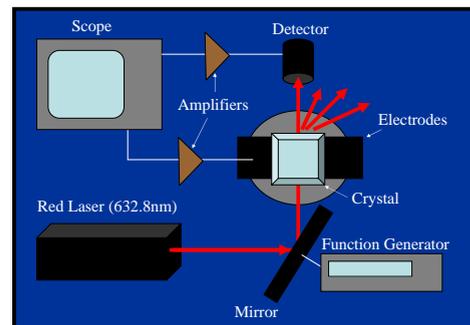
STATE OF THE ART AND TECHNOLOGY TRANSFER

Possible applications include: optical phase sensors, real-time, non-contact altitude determination, vibrometry, non-destructive testing with pulsed laser acoustics, biomedical acousto-phonic imaging, optical communication, and optical data storage (DoD). This work is supported through the DoD and the Department of the US Navy. It is under the RIA research for CenSSIS.

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EXPERIMENTAL SCHEMATIC



PRELIMINARY RESULTS AND ANALYSIS

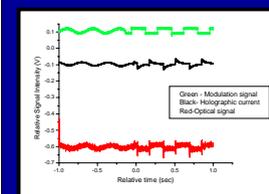


Figure 1) Single beam double Interferometry on SPS crystal showing the optical and electrical signals using visible laser.

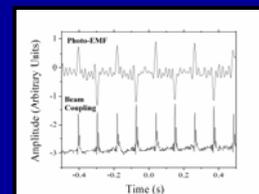


Figure 2) Double-dynamic Interferometry on CdTe crystal showing the optical and electrical signals using IR laser.

SUMMARY AND FUTURE STUDIES

In summary, we have described single-beam double-dynamic interferometer, based on the fast ferroelectric semiconductor crystal SPS:Sn and the semiconductor CdTe. Fast response (milliseconds) was observed with low-power HeNe laser (632.8 nm, 15 mW) with phase modulated signals. This interferometer is compact, robust, and does not need mechanical stabilization.

