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Optical Switching via Self-Diffraction in ITO

In ultra-high-speed communication, switching has the most urgent demand for high-speed process. The switching speeds of electronics cannot keep up with the transmission capacity offered by optics, so optical switching plays an important role in the future devices. In this work, we propose a setup for optical switching via third order nonlinear optical effect. The self-diffraction (SD) experimental setup is shown in Figure 1a. Self-diffraction involves the diffraction of light from a transient grating formed by the interference of two pulses in an absorbing medium. A 1-kHz repetition-rate laser beam from an optical parametric amplifier is used to pump the sample with pulses of peak and average powers of 0.1TW and 10mW, respectively. The laser system generates 0.01mJ energy pulses with a 200-fs pulse width. The output wavelength is 1350 nm. As nonlinear media, we use ITO due to its remarkable nonlinear third order optical properties in the infrared range [1]. Indium tin oxide (ITO) is a ternary composition of indium, tin and oxygen in varying proportions. Another advantage of ITO is that, since the bandgap of the material depends on its doping [2], it is possible to tune its nonlinear response. The presented experimental setup is versatile, and third harmonic generation (THG) from both beams can be used to align and monitor the system. Since THG is formed in the combination of 2 pump beams, the pattern, as shown in Figure 1b, is modulated as a $\cos^2(\theta)$ (θ: incident angle) across the plane of incidence. Our preliminary results show that SD can be efficiently generated. As shown in Figure 1c, SD signal presents a cubic dependence on the pump power. The slope is 2.83. More detailed experimental work about SD signal dependence on pump wavelength is ongoing.

Figures

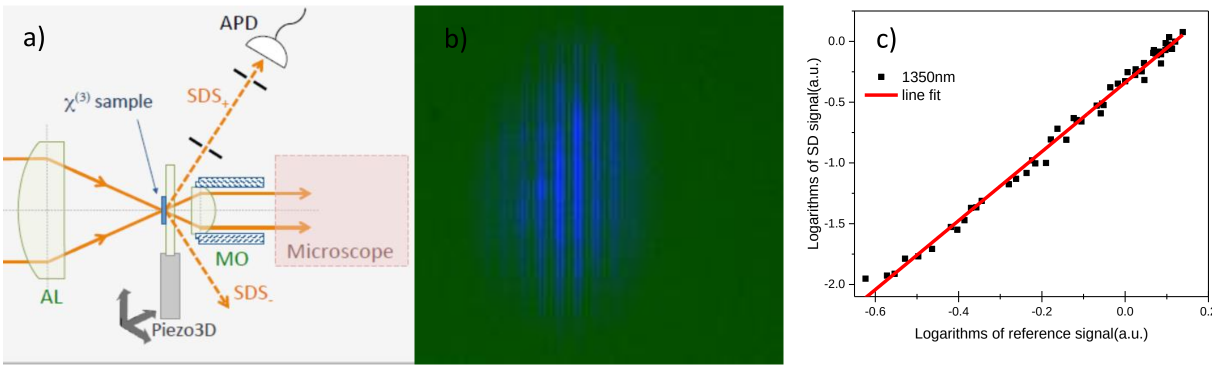

Figure 1: Self diffraction of ITO: a) setup; b) THG image fringes; c) Logarithms of SD and reference signal

References

[1] Alam, M. Zahirul, Israel De Leon, and Robert W. Boyd. Science 352.6287 (2016): 795-797

[2] Erhart, Paul. Physical Review B 75.15 (2007): 153205.