NONLINEAR REFRACTIVE INDEX MEASUREMENT IN THE INFRARED USING FEMTOSECOND LASER PULSES

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Nowadays the scientific research and experiments in the infrared (IR) attract a lot of interest as it is a promising area of high intensity laser physics, e.g. attosecond pulses generation [1]. However, even some parameters of optical materials used in the IR, are not well known. One of the most important parameters facilitating nonlinear phenomena is nonlinear refractive index or n_2.

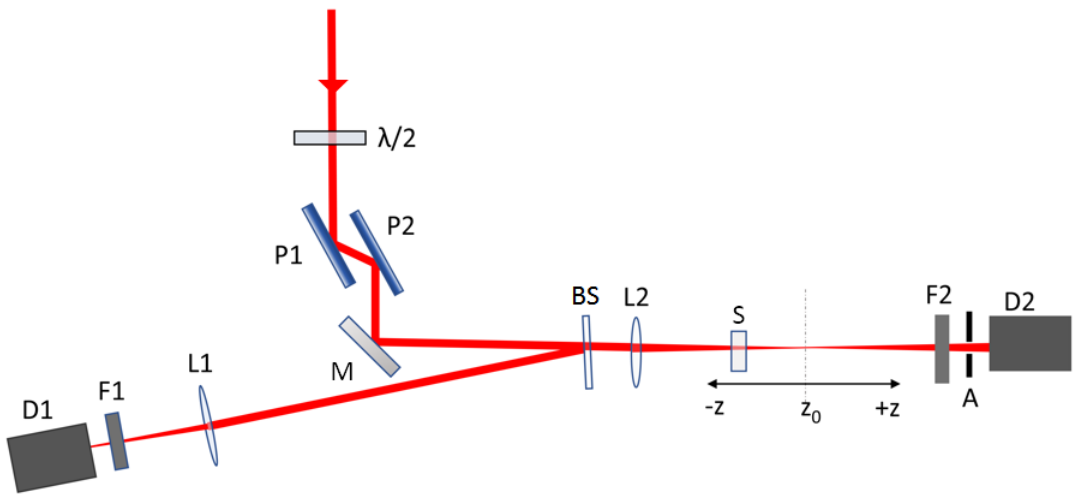
In this work, determination of nonlinear refractive index using a standard z-scan [2] technique for various samples - fused silica, sapphire, BK7 and KGW are presented. The z-scan experiment was carried-out using femtosecond laser sources at infrared wavelengths.

The z-scan technique allows to easily determine nonlinear refractive index (NLR) sign and magnitude as well as the impact of nonlinear absorption (NLA). The z-scan measurements are performed by translating the sample along the beam propagation axis and measuring the phase variation behind the aperture with a detector. A typical closed aperture z-scan shows characteristic valley-peak curve which indicates positive n_2 sign. Nonlinear refractive index is determined from phase change ($|\Delta\varphi|$) which is calculated from normalized transmittance curve difference between valley and peak. (ΔT_{p-v}) (Eq. (1,2)).

$$|\Delta\varphi| = \frac{\Delta T_{p-v}}{0,406(1-S)^{0,25}} \tag{1}$$

$$n_2 = \frac{k\Delta\varphi_0}{I_0 L_{eff}} = (\frac{\lambda}{2\pi})\frac{\Delta\varphi_0}{I_0 L_{eff}} \tag{2}$$

Here S is linear transmission of an aperture, I_0 - peak intensity, L_{eff} is effective sample length. The z-scan experimental setup for evaluation of the n_2 was developed, see Fig. 1. Here S - sample, $\lambda/2$ - half wave-plate, P1, P2 - Brewster type polarizers, L1, L2 - focusing lenses, BS - beam splitter, M - metal mirror, A - aperture, D1, D2 - detectors, F1, F2 - neutral density filters.



1 Fig.. Experimental scheme

The investigated optical materials were translated using a motorized delay line and the whole process of signal acquisition was automated and controlled via a LabView based program. From the closed and open aperture z-scan measurements, the nonlinear refractive index for fused silica, sapphire, BK7, KGW and AGS were determined and compared.

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