université de BORDEAUX

LOMA UMR5798 Laboratoire Ondes et Matière d'Aquitaine

Master 2 Internship

Title: Can a silicon wafer behave as a THz lens after being photo-excited by a femtosecond laser pulse?

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PhD funding (if any):

Project: Silicon (Si) semiconductor material is widely used in terahertz (THz) science and technology due to its low absorption coefficient [1, 2]. With a bandgap E_g = 1.14 eV, a visible or near infrared light can create photo-induced free carriers in Si which can locally modify the dielectric constant - and therefore the refractive index - of the material. The first objective of this internship is to highlight this variation of Si refractive index, particularly pronounced in the THz domain, under the excitation by an infrared femtosecond laser pulse. The second objective concerns the evaluation of the consequences of this index variation for a THz pulse passing through the photo-excited material.

To this end, we will use a THz radiation generated in a ZnTe non-linear crystal. After its illumination by a femtosecond infrared pulse, a Si wafer should behave like a lens with a variable focal length, directly related to the number of carriers created by the exciting laser pulse. To measure this property, which can give rise to interesting applications (manufacture of THz lenses of variable focal length), we will use a THz wavefront analyzer which makes it possible to precisely measure the defocus (variation in the radius of curvature) of the THz wave induced by the exciting optical laser pulse.

The internship will consist in different actions. First, the student will use a python code (already written) in order to simulate the variation of the dielectric constant of Si induced by the femtosecond infrared laser pulse. Then, he will conduct a new experiment on the COLA platform consisting in optical alignment with an amplified femtosecond laser source Ti:Sa (CPA type), generation and detection of THz pulses using non-linear crystals, imaging using a camera. A significant part of the work will concern the acquisition and processing of data (wavefront measurement, decomposition based on Zernike polynomials to measure the geometric aberrations of the THz wave, including the defocus).

[1] J. Dai, J. Zhang, W. Zhang, et D. Grischkowsky, « Terahertz time-domain spectroscopy characterization of the far-infrared absorption and index of refraction of high-resistivity, float-zone silicon », JOSA B 21(7), 1379 (2004).
[2] M. van Exter et D. Grischkowsky, « Carrier dynamics of electrons and holes in moderately doped silicon », Phys. Rev. B 41(17), 12140 (1990).