Investigation of population inversion caused refractive index changes in Ti:Sapphire at room and cryogenic temperatures

Viktor Zuba[1], Roland S. Nagymihaly[1,2], Huabao Cao[2], Peter Jojart[1,2], Roland Flender[1], Adam Borzsonyi[1,2], Vladimir Chvykov[2], Karoly Osvay[2], Mikhail Kalashnikov[2,3]

[1]Department of Optics and Quantum Electronics, University of Szeged, P.O. Box 406, H-6701 Szeged, Hungary
[2]ELI-HU Non-Profit Ltd., Dugonics tér 13., Szeged, Hungary
[3]Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Max-Born-Strasse 2a, 12489 Berlin, Germany

Laser systems based on Ti:Al_2O_3 (Ti:Sapphire) crystals are the most widely used instruments nowadays for research and biological applications. The ultrashort pulses generated by these systems are routinely amplified by the chirped pulse amplification technique. Amplification stages based on this method pushed the frontiers of science, opening new fields of research including attosecond science, or laser induced particle acceleration. However, there are several pulse distortions, which may arise during amplification. One of the most crucial phenomena is the spectral phase modulation in the amplifier stages.

In this project the inversion induced refractive index changes have been experimentally investigated. The measurements were performed for both π- and σ-polarized pulses with a spectrum covering the 700-900 nm wavelength range. The experimental setup was designed to maximize stability. To attain the desired precision, a Jamin-interferometer was implemented. The thermally induced effects were successfully separated and subtracted during the evaluation process. The phase-modulation of electronic origin was determined for different pump energy fluence values. The effect was investigated at room and cryogenic temperatures. The obtained results are crucial for CEP stabilization and compression of high energy, few cycle pulses generated by polarization-encoded Ti:Sapphire amplifier systems.

Keywords: Ultrashort laser pulses, Ti:Sapphire, Laser pulse amplification