Thermal Lens analisys with Two-wavelength Speckle Interferometry

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Thermal effects are often a limiting in solid-state lasers research when designing new optical resonators, affecting the stability, optical beam quality and output power of the laser. Besides determining the upper limit of incident pump power in function of mechanical tension generated by non-linear heating. With this work we develop a new method for the study of thermal lensing effect with a two-wavelength DSPI (Digital Speckle Pattern Interferometry) setup for wavefront sensing. The geometry of the sensor enables the detection of wavefronts produced by phase distorters and by induced lenses as well. The interference fringes describing the wavefront are formed onto a diffusely glass plate and the wavefront is reconstructed upon fringe evaluation through phase stepping techniques and phase unwrapping procedures.

Both lasers were properly tuned and aligned in order to have the same propagation direction and to be spatially superimposed. Real-time single-exposure contour interferograms could be obtained in order to get discernible and low-spacial frequency contour fringes and obtain low-noise measurements. By properly translating this component in the aperture plane, the speckle patterns were used to reconstruct the wavefront by applying a phase retrieval iterative algorithm.

For our experiments we chose to quantify the thermal lens effect in a 4% Er-doped $CaO\text{-}Al_2O_3$ glass sample. The diode lasers were tuned to have a contour interval of around 120μm. The incident pump power was placed longitudinal and collinear with the probe beams. Each interferogram presented a spherical-like wavefront, with the wellknow ABCD matrix formalism we could easily extract the focal length induced by the thermal effect for different absorbed pump power. The absorption spectrum was obtained in order to quantify the absorbed pump power in the sample. Wavefront reference was obtained without the pump beam. The focal lengths were 131,39mm and 42,76mm for the sample absorbing 15mW and 600mw of the pump power, respectively.