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# *Writing 3D refractive index modifications in ophthalmic polymers and ocular tissues - a novel means of altering refraction and biomechanics with minimal cellular damage*

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We previously reported on the use of tightly focused, high repetition rate, nanojoule energy femtosecond pulses in the near infrared to write permanent, high quality, 3D, strong refractive index modifications into hydrogels and other polymers. Here, we discuss the optimization of laser and material properties, and progress toward devices and applications.

In particular, we describe the use of this process to non-destructively alter the optical properties of living, transparent tissues, such as the cornea and the lens. The experiments here described used high repetition rate (82 MHz), 100 femtosecond laser pulses at either 800 or 400nm to inscribe patterns of refractive index (RI) change inside freshly-excised corneas kept alive in Optisol-GS. We named this process Intra-tissue Refractive Index Shaping (IRIS) since it locally alters the stromal RI by 0.005 to 0.037, depending on the laser wavelength and power used, its scanning speed and the tissue's two-photon absorption spectrum.

Results obtained by using exogenous, two-photon chromophores (that are doped into the tissue) are compared with endogenous two-photon absorption of undoped tissue using 400nm femtosecond laser pulses. In both cases, we found a significant increase in both the scanning speed and magnitude of RI change attainable. RI changes were associated with densification of collagen fibrils, but importantly, TUNEL staining showed no cell death in regions of pure RI change. Ongoing in situ experiments will verify the long-term effects of IRIS on corneal biology, biomechanics and optics.

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