Section:
Terahertz Optics and Biophotonics VI

Title:
THz polarization-sensitive solid immersion microscopy of brain tissues

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Abstract:
Terahertz (THz) technology has diverse applications in label-free medical diagnosis and therapy [1–3]. However, many of these applications rely on the effective medium theory, which consider biological tissues as optically isotropic and homogeneous at the scale of THz wavelengths. Recent research, however, has discovered mesoscale (~λ) heterogeneities in tissues, where λ represents the wavelength. To overcome this, we developed a polarization-sensitive reflection-mode THz solid immersion (SI) microscope [4–7]. This microscope, consisting of a silicon hemisphere-based SI lens, metal-wire-grid polarizer and analyzer, a 0.6 THz backward-wave oscillator (BWO), and a Golay detector. Our microscope enables the study of local polarization-dependent responses of mesoscale tissue elements with a high resolution of 0.15λ. The microscope was employed to investigate the THz birefringence (structural optical anisotropy) of freshly-excised rat brain tissue. Remarkable birefringence was observed in the *Corpus callosum*, which contains well-oriented and densely-packed axons connecting the cerebral hemispheres. These findings were verified by THz pulsed spectroscopy of pig brain samples, which confirmed a higher refractive index in the *Corpus callosum* when the THz beam was polarized along the axons. The results highlight the potential of polarization-sensitive THz microscopy in biophotonics and medical imaging.

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