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Development of
an Optical Coherence Tomography system
and its application in surface morphology imaging
of an optical material

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Abstract

A Spectral-Domain Optical Coherence Tomography (OCT) system was developed by illuminating a Michelson interferometer with a broadband light-emitting diode. The system was developed for the purpose of surface profilometry of an optical material using the first reflection surface profilometry technique. Analytic solutions of the interference signal of a single wavelength, two-wavelength, polychromatic line and broadband sources were derived using the electric field solution to the wave equation. Simulations of interferograms from a Michelson interferometer illuminated with light sources of varying coherence lengths were developed to predict output intensity measurements. Spectral interferograms of broadband sources were then measured in the frequency domain using a Czerny-Turner mount monochromator with a 2048-element complementary metal oxide semiconductor linear array as the detector. One dimensional axial OCT images were computed by Fourier transformation of the measured spectra. Two dimensional colour-scaled slice images were then compiled by concatenation of 29 and 15 axial scans obtained from a 14 mm and 3.5 mm slice length respectively. Measured spectral interferograms, computed interference fringe signals and depth reflectivity profiles were comparable to simulations. Axial resolution of the imaging system was 14.05 μm and 9.69 μm using the 635 nm and 850 nm source respectively. Surface profile images of a double-step-function-surfaced sample showed a mean step height of 161.00 ± 1.00 μm while line profiles of 0.5 mm-wide cracks revealed a mean crack depth of 163.00 ± 1.00 μm, values which corresponded to thickness of microscope cover-slips used to fabricate the sample. Computed mean inclination angle of the sample relative to the incident beam was 1.82°, confirming sensitivity of the system to detect minute misalignments.