Combining Spatial and Temporal Coherence with the Full Field Linnik Interference Microscope for OCT

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Low-coherence interference microscopy (LCIM) can be classified into two types, both acts as three-dimensional imaging tool. The one based primarily on low spatial coherence is known as coherence probe microscope (CPM) and used extensively as phase imaging high-resolution microscope for surface inspection and profiling, particularly in the semiconductor device fabrication industry. The other is based primarily on low temporal coherence is known as optical coherence tomography (OCT) microscope and it is being used for medical diagnostics, particularly in ophthalmology and dermatology. The LCIM has many advantages over conventional microscopy or conventional interferometry in its ability to discriminate between different transparent layers and in a scattering medium thus allowing for precise noninvasive optical probing of dense tissue and other turbid media. Limitations of each technique will be presented and their performance will be compared. Advantages of using mixed configurations that use both techniques in one tool as well as the advantage of low coherence confocal microscope will be discussed. Distinction between spatial and temporal coherence characteristics of the interferrogram from low coherence microscopic systems are investigated experimentally and theoretically based on the scalar imaging theory. It is shown that the coherence region is determined by the temporal coherence only when the path length difference is scanned in a region where the reference and sample beams are collimated with the same spatial frequency. Spatial coherence takes an effect when the path length scan is performed with un-collimated beam such as defocus scan of a lens where the focal depth of the lens mainly determines the coherence region. In the latter case the fringe size for a monochromatic light is smaller than half the wavelength by a factor determined by the spatial coherence. When the OCT system uses both spatial and temporal coherence then it is shown that for each spatial coherence length, there is a limit on the temporal coherence, above which it stops to affect the interferrogram width. This limit gives lower limit on the effective NA, required for the temporal coherence not to influence the interferrogram width.

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