

MULTIMODAL THREE-DIMENSIONAL INTERFERENCE MICROSCOPY

Julien Moreau, Gael Moneron, Kate Grieve, Claude Boccara, Arnaud Dubois
Laboratoire Charles Fabry de l'Institut d'Optique
Centre National de la Recherche Scientifique, UMR 8501
Université Paris-Sud
Campus Polytechnique RD 128
91127 Palaiseau, France
Email: arnaud.dubois@institutoptique.fr

KEY WORDS: interference microscopy, white-light interferometry, optical coherence tomography, polarization, spectroscopy.

We have developed an interference microscope for three dimensional imaging of biological media with multiple modalities. Intensity, spectrum and polarization of light backscattered by the object structures can be measured with ultrahigh spatial resolution. The Linnik-type microscope is illuminated by a halogen lamp and the interferometric images are acquired by CCD cameras. The broad spectrum of the illumination source enables to achieve spectroscopic imaging over a wavelength range from 600 to 1000 nm. Due to the weak temporal coherence of the light and the relatively high objective numerical aperture, an isotropic imaging spatial resolution is obtained according to the principle of Optical Coherence Tomography (OCT) [1-5]. Local spectroscopic measurements are achieved by short-time Fourier analysis of a stack of *en-face* interferometric images. The intensity images are calculated using a phase-shifting method. Birefringence properties of the object can also be measured by combination of orthogonally polarized interferometric images acquired simultaneously by two CCD cameras. Full-field illumination circumvents the necessity of scanning required in confocal microscopy. The capabilities of this microscope are demonstrated by imaging of various biological tissues. Some application examples are presented in embryology, developmental biology, and ophthalmology.

- [1] D. Huang, E. A. Swanson, C. P. Lin, J. S. Schuman, W. G. Stinson, W. Chang, M. R. Hee, T. Flotte, K. Gregory, C. A. Puliafito, and J. G. Fujimoto, *Science* **254**, 1178 (1991).
- [2] A. F. Fercher, *J. Biomed. Opt.* **1**, 157 (1996).
- [3] W. Drexler, U. Morgner, F. X. Kärtner, C. Pitris, S. A. Boppart, X. D. Li, E. P. Ippen, and J. G. Fujimoto, *Opt. Lett.* **24**, 1221 (1999).
- [4] L. Vabre, A. Dubois, A.C. Boccara, *Opt. Lett.* **27**, 530 (2002).
- [5] A. Dubois, K. Grieve, G. Moneron, R. Lecaque, L. Vabre, and A.C. Boccara, *Appl. Opt.* **43**, 2874 (2004).