

المراجع

References

- [1] J. Workman, A. Springsteen (eds.), *Applied Spectroscopy A Compact Reference for Practitioners* (Academic Press, San Diego, 1998)
- [2] J. Kauppinen, J. Partanen, *Fourier Transform Spectroscopy* (Wiley-VCH, Berlin, 2001)
- [3] D.M. Scott, A two-colour near-infrared sensor for sorting recycled plastic waste. *Meas. Sci. Technol.* 6, 156–159 (1995)
- [4] V. Lucarini, J.J. Saarinen, K.-E. Peiponen, E.M. Vartiainen, *Kramers-Kronig Relations in Optical Materials Research* (Springer, Berlin, 2005)
- [5] A.L. Waterhouse, J.A. Kennedy, *Red Wine Color* (American Chemical Society, Washington, DC, 2004)
- [6] Noiseux, W. Long, A. Cournoyer, Simple fiber-optic-based sensor for process monitoring: An application in wine quality control monitoring. *Appl. Spectrosc.* 58, 1010–1019 (2004)
- [7] C.F. Bohren, D.R. Huffman, *Absorption and Scattering of Light by Small Particles* (Wiley, New York, 1983)
- [8] L.M.C. Oliveira, M.A.C.P. Clemente, Port wine spectrophelometry. *Opt. Laser Technol.* 35, 491–496 (2003)
- [9] J. Rˆaty, K.-E. Peiponen, T. Asakura, *UV-Visible Reflection Spectroscopy of Liquids* (Springer, Berlin, 2004)
- [10] K.-E. Peiponen, E.M. Vartiainen, T. Asakura, *Dispersion, Complex Analysis and Optical Spectroscopy* (Springer, Berlin, 1999)
- [11] K.-E. Peiponen, E.M. Vartiainen, Dispersion theory of the reflectivity of *s*-polarized and *p*-polarized light. *J. Opt. Soc. Am. B.* 23, 114–119 (2006)
- [12] M.O.A. Mˆakinen, K.-E. Peiponen, J. Rˆaty, V. Hyvˆarinen, Reflectance and probe window contamination: study of pulping solutions. *Appl. Spectrosc.* 55, 852–857 (2001)

- [13] H. Soetedjo, J. R"aty, Reflectometric study of contaminat layer on a probe window. *Appl. Spectrosc.* 57, 915–919 (2003)
- [14] Niskanen, J. R"aty, K.-E. Peiponen, Complex refractive index of tirbid liquids, *Opt. Lett.* 32, 862–864 (2007)
- [15] Niskanen, J. R"aty, K.-E. Peiponen, H. Koivula, M. Toivakka, Assessment of the complex refractive index of an optically very dense solid layer: Case study of offset magenta ink. *Chem. Phys. Lett.* 442, 515–517 (2007)
- [16] Niskanen, J. R"aty, K.-E. Peiponen, Estimation of effective refractive index of birifringent particles using a combination of the immersion liquid method and light scattering. *Appl. Spectrosc.* 62, 399–401 (2008)
- [17] H. R"ather, *Surface Plasmons on Smooth and Rough Surfaces and on Gratings* (Springer, Berlin, 1988)
- [18] J. Homola, S.S. Yee, G. Gauglitz, Surface plasmon resonance sensors: review. *Sens. Actuators B* 54, 3–15 (1999)
- [19] K. Matsubara, S. Kawata, S. Minami, Optical chemical sensor based on surface plasmon measurement. *Appl. Opt.* 27, 1160–1163 (1988)
- [20] R.J. Green, R.A. Frazier, K.M. Shakesheff, M.C. Davies, C.J. Roberts, S.J.B. Tendler, Surface plasmon resonance analysis of dynamic biological interactions with biomaterials. *Biomaterials* 21, 1823–1835 (2000)
- [21] B.J. Sedlak, Next generation microarray technologies – focus is on higher sensitivity, drug discovery, and lipid cell signaling. *Genet. Eng. News* 23, 20 (2003)
- [22] J. Liu, S. Tian, L. Tiefenauer, P.E. Nielsen, W. Knoll, Simultaneously amplified electrochemical and surface plasmon optical detection of DNA hybridization based on ferrocene-streptavidin conjugates. *Anal. Chem.* 77, 2756–2761 (2005)
- [23] A.J. J"a"askel"ainen, K.-E. Peiponen, J.A. R"aty, On reflectometric measurement of a refractive index of milk. *J. Dairy Sci.* 84, 38–43 (2001)
- [24] M. Zangeneh, N. Doa, E. Sambriski, R.H. Terrill, Surface plasmon spectral finger-printing of adsorbed magnesium phthalocyanine by angle and wavelength modulation. *Appl. Spectrosc.* 58, 10–17 (2004)
- [25] A.J. Haes, R.P. Van Duyne, Preliminary studies and potential applications of localized surface plasmon resonance spectroscopy in medical diagnostics. *Expert Rev. Mol. Diagn.* 4, 527–537 (2004)
- [26] E.M. Vartiainen, J.J. Saarinen, K.-E. Peiponen, Method for extracting the complex dielectric function of nanospheres in a water matrix from surface Plasmon resonance data. *J. Opt. Soc. Am. B* 22, 1173–1178 (2005)
- [27] P. Kubelka, F. Munk, Ein Beitrag zur Optik der Farbanstriche. *Zeitschrift für technische Physik* 12, 593–601 (1931)
- [28] G. Kort"um, *Reflectance Spectroscopy Principles, Methods, Applications* (Springer, Berlin, 1969)
- [29] D.A.G. Bruggeman, Berechnung versciедener physikalischer Konstanten von heterogenen Substanzen. *Ann. Phys. (Leipzig)* 24, 636–679 (1935)

- [30] X.C. Zeng, D.J. Bergman, P.M. Hui, D. Stroud, Effective-medium theory for weakly nonlinear composites. *Phys. Rev. B* 38, 10970–10973 (1988)
- [31] K.-E. Peiponen, E. Gornov, Description of Wiener bounds of multi-component composites by barycentric coordinates. *Opt. Lett.* (in press)
- [32] A.J. Jämskäinen, K.-E. Peiponen, J. Rintamäki, U. Tapper, O. Richard, E.I. Kauppinen, K. Lumme, Estimation of the refractive index of plastic pigments by Wiener bounds. *Opt. Eng.* 39, 2959–2963 (2000)
- [33] K.-E. Peiponen, E. Gornov, On prediction of optical properties of two- and multiphase nanocomposites for nanomedicine. *Int. J. Nanomed.* 2, 799–804 (2007)
- [34] Y.R. Shen, *The Principles of Nonlinear Optics* (Wiley, New York, 1984)
- [35] R.W. Boyd, *Nonlinear Optics* (Academic Press, New York, 2003)
- [36] P. Hänninen, A. Soini, N. Meltola, J. Soini, J. Soukka, E. Soini, A new microvolume technique for bioaffinity assays using two-photon excitation. *Nat. Biotechnol.* 18, 548–550 (2000)
- [37] J. Bretschneider, Application of the optical testing procedure to quality control of flat glass. *Glasstech. Ber.* 61, 172–175 (1988)
- [38] J. Rintamäki, K.-E. Peiponen, On-line measurement of the thickness and optical quality of float glass with a sensor based on a diffractive element. *Appl. Opt.* 40, 5034–5039 (2001)
- [39] B.R. Brown, A.W. Lohmann, Complex spatial filtering with binary masks. *Appl. Opt.* 5, 967 (1966)
- [40] M. Nieto-Vesperinas, *Scattering and Diffraction in Physical Optics* (Wiley, New York, 1991)
- [41] S.M. Chapman, *Pulp Paper Mag. Can.* 55, 88 (1954)
- [42] G. Blokhuis, P.J. Kalff, *Tappi J.* 59, 107 (1976)
- [43] Oksman, R. Silvennoinen, K.-E. Peiponen, M. Avikainen, H. Komulainen, Reflectance study of paper. *Appl. Spectrosc.* 58, 481–485 (2004)
- [44] M. Aikio, Hyperspectral prism-grating-prism imaging spectrograph. *VTT Publications* 435, PhD Dissertation (2001)
- [45] D.J. Whitehouse, A philosophy of linking manufacture to function—an example in optics. *Proc. Inst. Mech. Engrs.* 207, 31–42 (1993)
- [46] J.M. Bennett, L. Matsson, *Introduction to Surface Roughness and Scattering* (Optical Society of America, Washington DC, 1989)
- [47] Ogilvy, J.R. Foster, Rough surfaces: gaussian or exponential statistics? *J. Phys. D: Appl. Phys.* 22, 1243–1251 (1989)
- [48] P. Beckmann, A. Spizzichino, *The Scattering of Electromagnetic Waves from Rough Surfaces* (Pergamon Press, Oxford, 1963)
- [49] P. Cielo, *Optical Techniques for Industrial Inspection* (Academic Press, San Diego, 1988)
- [50] H. Davies, The reflection of electromagnetic waves from rough surface, *Monograph No 90 RADIO SECTION*, 209–214 (1954)

- [51] R. Silvennoinen, K.-E. Peiponen, V. Hyvärinen, P. Raatikainen, P. Paronen, Optical surface roughness study of starch acetate compacts. *Int. J. Pharm.* 182, 213–220 (1999)
- [52] V. Hyvärinen, K.-E. Peiponen, R. Silvennoinen, P. Raatikainen, P. Paronen, T. Niskanen, Optical inspection of punches: flat surfaces. *Eur. J. Pharm. Biopharm.* 49, 87–90 (2000)
- [53] G.S. Spagnolo, D. Ambrosini, Diffractive optical element based sensor for roughness measurement. *Sens. Actuators A* 100, 180–186 (2002)
- [54] R. Silvennoinen, K.-E. Peiponen, T. Asakura, Diffractive optical elements in materials inspection, in *International Trends in Optics and Photonics ICO IV*, ed. by T. Asakura (Springer, Berlin, 1999), pp. 281–293
- [55] C. Gu, K.-E. Peiponen, R. Silvennoinen, J. Luostarinen, J. Uozumi, T. Asakura, A simple proximity sensor for metal surface quality monitoring. *Precis. Eng.* 16, 219–222 (1994)
- [56] K.-E. Peiponen, E. Alarousu, M. Juuti, R. Silvennoinen, A. Oksman, R. Myllylä, T. Prykäri, Diffractive-optical element-based glossmeter and low coherence interferometer in assessment of local surface quality of paper. *Opt. Eng.* 45, 436011–436017 (2006)
- [57] M. Juuti, T. Prykäri, E. Alarousu, H. Koivula, M. Myllylä, A. Lähteelä, M. Toivakka, J. Timonen, R. Myllylä, K.-E. Peiponen, Detection of local specular gloss and surface roughness from black prints. *Colloids Surf. A* 299, 101–108 (2007)
- [58] V.G.W. Harrison, *Definition and Measurement of Gloss* (W. Hefner and Sons Ltd, Cambridge, 1940)
- [59] R.S. Hunter, R.W. Harold, *The Measurement of Appearance* (Wiley, New York, 1987)
- [60] J.S. Christie, An instrument for the geometric attributes of metallic appearance. *Appl. Opt.* 8, 1777–1785 (1969)
- [61] H. Assender, V. Bliznyuk, K. Porfyrakis, How surface topography relates to materials. *Properties. Science* 297, 973–976 (2002)
- [62] T. Glatzer, D.W. Bousfield, Print gloss development on a model substrate. *Tappi J.* 80 125–131 (1997)
- [63] J.S. Preston, N.J. Elton, J.C. Husband, J. Dalton, P.J. Heard, G.C. Allen, Investigation into the distribution of ink components on printed coated paper. Part 1: optical and roughness considerations. *Colloids Surf. A* 205, 183–198 (2002)
- [64] K. Myller, K.-E. Peiponen, R. Silvennoinen, J.-P. Tarvainen, J. Rainio, S. Soimila-Oksanen, Glossmeter for detection of gloss and wear of concave glazed ceramic products. *cfi/Ber. DKG* 81, E39–E42 (2004)
- [65] K. Myller, M. Juuti, K.-E. Peiponen, R. Silvennoinen, E. Heikkinen, Quality inspection of metal surfaces by diffractive optical glossmeter. *Precis. Eng.* 30, 443–447 (2006)
- [66] K.-E. Peiponen, M. Juuti, Statistical parameters for gloss evaluation. *Appl. Phys. Lett.* 88, 0711041–0711043 (2006)

- [67] Oksman, M. Juuti, K.-E. Peiponen, Sensor for the detection of local contrast gloss of products. *Opt. Lett.* 33, 654–656 (2008)
- [68] Oksman, M. Juuti, K.-E. Peiponen, Statistical parameters and analysis of local contrast gloss. *Opt. Express* 16, 12415–12422 (2008)
- [69] Mäkynen, Position-sensitive devices and sensor systems for optical tracking and displacement sensing applications. *Acta Univ Oul C* 151, DSc Thesis (2000)
- [70] T. Bosch, M. Lescure (eds.), *Selected Papers on Laser Distance Measurement* (SPIE Milestone Series MS 115, 1995)
- [71] M.-C. Amann, T. Bosch, M. Lescure, R. Myllylä, M. Rioux, Laser ranging: a critical review of usual techniques for distance measurement. *Opt. Eng.* 40, 10–19 (2001)
- [72] S. Donati, *Electro-Optical Instrumentation* (Prentice Hall, New Jersey, 2004)
- [73] T. Dresel, G. Häusler, H. Venzke, Three-dimensional sensing of rough surfaces by coherence radar. *Appl. Opt.* 31, 919–925 (1992)
- [74] M.E. Brezinski, J.G. Fujimoto, Optical coherence tomography: High-resolution imaging in nontransparent tissue. *IEEE J. Select. Top. Quantum Electron.* 5, 1185–1192 (1999)
- [75] P.H. Tomlins, R.K. Wang, Theory, developments and applications of optical coherence tomography. *J. Phys. D: Appl. Phys.* 38, 2519–2535 (2005)
- [76] E. Alarousu, Low coherence interferometry and optical coherence tomography in paper measurements. *Acta Univ. Oul C* 256, DSc Thesis (2006)
- [77] S. Poujoly, B. Journet, Laser range finding by phase-shift measurement: moving towards smart systems. *Proc. SPIE* 4189, 152–160 (2000)
- [78] Journet, G. Bazin, A low-cost laser range-finder based on an FMCW-like method. *IEEE Trans. Instrum. Meas.* 49, 840–843 (2000)
- [79] Kaisto, J. Kostamovaara, M. Manninen, R. Myllylä, Optical range finder for 1.5–10m distances. *Appl. Opt.* 22, 3258–3264 (1983)
- [80] Castagnet, H. Tap-B'eteille, M. Lescure, Avalanche-photodiode-based heterodyne optical head of a phase-shift laser range finder. *Opt. Eng.*, 45, 043003-1–043003-7 (2006)
- [81] C.E. Cook, M. Bernfield, *Radar Signals, An Introduction to Theory and Application* (Academic, New York, 1967)
- [82] N.J. Mohamed, Resolution function of nonsinusoidal radar signals: II-range/velocity resolution with pulse compression techniques. *IEEE Trans. Electromagn. Compat.* 33, 51–58 (1991)
- [83] T. Ruotsalainen, P. Palojärvi, J. Kostamovaara, A current-mode gain-control scheme with constant bandwidth and propagation delay for transimpedance preamplifier. *IEEE J. Solid-State Circuits* 34, 253–258 (1999)
- [84] J.-P. Jansson, A. Mäntyniemi, J. Kostamovaara, A CMOS time-to-digital converter with better than 10 ps single-shot precision. *IEEE J. Solid-State Circuits* 41, 1286–1296 (2006)
- [85] K. Mättä, J. Kostamovaara, R. Myllylä, Profiling of hot surfaces by pulsed time-of-flight laser range finder techniques. *Appl. Opt.* 32, 5334–5347 (1993)

- [86] M.R. Maier, P. Sperr, On the construction of a fast constant fraction trigger with integrated circuits and application to various phototubes. *Nucl. Instrum. Methods* 87, 13–18 (1970)
- [87] A.J. Joblin, Method of calculating the image resolution of a near-infrared time-of-flight tissue-imaging system. *Appl. Opt.* 35, 1996, 752–757 (1996)
- [88] J. Carlsson, P. Hellentin, A. Malmqvist, W. Persson, C-G Wahlström, Timeresolved studies of light propagation in paper. *Appl. Opt.* 34, 1528–1535 (1995)
- [89] H. Lahtinen, M. Jurvakainen, P. Pramila, H. Tabell, M. Kusevic, O. Hormi, V. Lyöri, M. Heikkinen, R. Myllylä, P. Suopajärvi, H. Kopola, Utilisation of optical fibre measurement techniques in determination of residual stresses of composites. *Proc. SPIE* 3746, 526–529 (1999)
- [90] Kilpelä, Pulsed time-of-flight laser ranger finder techniques for fast, high precision measurement applications. *Acta Univ Oul C* 197, DSc Thesis (2004)
- [91] R. Myllylä, J. Marszalec, J. Kostamovaara, AM² antyniemi, G.-J. Ulbrich, Imaging distance measurements using TOF lidar. *J. Opt.* 29, 188–193 (1998)
- [92] J. Varela, A PET imaging system dedicated to mammography. *Radiat. Phys. Chem.* 76, 347–350 (2007)
- [93] M.A. Albota, R.M. Heinrichs, D.G. Kocher, D.G. Fouche, B.E. Player, M.E. O'Brien, B.F. Aull, J.J. Zayhowski, J. Mooney, B.C. Willard, R.R. Carlson, Three-dimensional imaging laser radar with a photon-counting avalanche photodiode array and microchip laser. *Appl. Opt.* 41, 7671–7678 (2002)
- [94] B.F. Aull, A.H. Loomis, D.J. Young, R.M. Heinrichs, B.J. Felton, P.J. Daniels, D.J. Landers, Geiger-Mode avalanche photodiodes for three-dimensional imaging. *Lincoln Lab. J.* 13, 335–350 (2002)
- [95] J.W. Weingarten, G. Gruener, R. Siegwari, A state-of-the-art 3D sensor for robot navigation. *Proc. 2004 IEEE/RSJ Int. Conf. Intell. Robots Syst.*, September 28. October 2, 2155–2160 (2004)
- [96] J. Busck, H. Heiselberg, Gated viewing and high-accuracy three-dimensional laser radar. *Appl. Opt.* 43, 4705–4710 (2004)
- [97] P. Andersson, Long-range three-dimensional imaging using range-gated laser radar images. *Opt. Eng.* 45, 034301-1-034301-10 (2006)
- [98] J.J. Zayhowski, A.L. Wilson Jr., Miniature eye-safe laser system for high-resolution three-dimensional lidar. *Appl. Opt.* 46, 5951–5956 (2007)
- [99] Mäkynen, J. Kostamovaara, R. Myllylä, Displacement sensing resolution of position-sensitive detectors in atmospheric turbulence using retroreflected beam. *IEEE Trans. Instrum. Meas.* 46, 1133–1136 (1997)
- [100] S. Donati, C.-Y. Chen, C.-C. Yang, Uncertainty of positioning and displacement measurements in quantum and thermal regimes. *IEEE Trans. Instrum. Meas.* 56 (2007), 1658–1665 (2007)
- [101] Mäkynen, J. Kostamovaara, R. Myllylä, Positioning resolution of the position-sensitive detectors in high background illumination. *IEEE Trans. Instrum. Meas.* 45, 324–326 (1996)

- [102] Mäkynen, J. Kostamovaara, Accuracy of lateral displacement sensing in atmospheric turbulence using a retroreflector and a position-sensitive detector. *Opt. Eng.* 36, 3119–3126 (1997)
- [103] J.H. Churnside, R.J. Latatis, Wander of an optical beam in the turbulent atmosphere. *Appl. Opt.* 29, 926–930 (1990)
- [104] M.L. Plett, Free-space optical communication link across 16 kilometers to a modulated retro-reflector array. Dissertation Submitted to the Faculty of the Graduate School of the University of Maryland, College Park, Electrical Engineering, 1–165 (2007)
- [105] Mäkynen, J. Kostamovaara, R. Myllylä, A high resolution lateral displacement sensing method using active illumination of a cooperative target and focused four-quadrant position-sensitive detector. *IEEE Trans. Instrum. Meas.* 44, 46–52 (1995)
- [106] M. Tervaskanto, Laser targeted Finland focus. *Traffic Technol. Int.*, Dec 2004/Jan 2005, 48–50 (2005)
- [107] Douxchamps, B. Macq, K. Chihara, High accuracy traffic monitoring using road-side line-scan cameras. *Proc. IEEE ITSC 2006*, 875–878 (2006)
- [108] V. Tuchin, *Tissue Optics* (SPIE Press, Bellingham, 2000)
- [109] Chance, Time resolved spectroscopic (TRS) and continuous wave (CWS) studies of photon migration in human arms and limbs. *Adv. Exp. Med. Biol.* 248, 21–31 (1989)
- [110] T. Svensson, J. Swartling, P. Taroni, A. Torricelli, P. Lindblom, C. Ingvar, S. Andersson-Engels, Characterization of normal breast tissue heterogeneity using time-resolved near-infrared spectroscopy. *Phys. Med. Biol.* 50, 2559–2571 (2005)
- [111] L.C. Enfield, A.P. Gibson, N.L. Everdell, D.T. Delpy, M. Schweiger, S.R. Arridge, C. Richardson, M. Keshtgar, M. Douek, J.C. Hebden, Threedimensional time-resolved optical mammography of the uncompressed breast. *Appl. Opt.* 46, 3628–3638 (2007)
- [112] V.V. Tuchin, X. Xu, R.K. Wang, Dynamic optical coherence tomography in studies of optical clearing, sedimentation, and aggregation of immersed blood. *Appl. Opt.* 41, 258–271 (2002)
- [113] J. Saarela, Photon migration in pulp and paper. *Acta Univ Oul C 213*, DSc Thesis (2004)
- [114] Karppinen, A. Kilpelä, M. Karras, J. Tornberg, R. Myllylä, Papermaking furnish properties estimated by time-resolved spectroscopy. *J. Pulp Paper Sci.* 21, J151–J154 (1995)
- [115] J. Saarela, R. Myllylä, Changes in the time-of-flight of a laser pulse during paper compression. *J. Pulp Paper Sci.* 29, 224–227 (2003)
- [116] T. Fabritius, Optical method for liquid sorption measurements in paper. *Acta Univ Oul C 269*, DSc Thesis (2007)
- [117] Stifter, Beyond biomedicine: a review of alternative applications and developments for optical coherence tomography. *Appl. Phys. B88*, 337–357 (2007)

- [118] M. Jurvakainen, H. Lahtinen, P. Peltomäki, A. Pramila, V. Lyori, R. Myllylä, M. Heikkinen, P. Suopajarvi, H. Kopola, Determination of farfield strain in a composite structure using time-of-flight and fabry-perot optical fibre sensors. Proc. SPIE 4074, 427–434 (2000)
- [119] T. Myllylä, H. Lahtinen, H. Sorvoja, R. Myllylä, Case studies on a wireless fibre Bragg grating condition monitoring system for rotating composite cylinders. Conf. Networked Sens. Syst. INSS'07, 69–72 (2007)
- [120] V. Lyöri, A. Mäntyniemi, A. Kilpelä, Q. Duan, J. Kostamovaara, A fibre-optic time-of-flight radar with a sub-metre spatial Resolution for the measurement of integral strain. Proc. SPIE 5050, 322–332 (2003)
- [121] V. Lyöri, A. Kilpelä, G. Duan, A. Mäntyniemi, J. Kostamovaara, Pulsed time of- flight radar for fiber-optic strain sensing. Rev. Sci. Instrum. 78, 0247051– 0247058 (2007)
- [122] Lichtberger, *Track Compendium* (Eurailpress, Hamburg, 2005)
- [123] J. Heinula, V. Nissinen, Shooting training: a principled approach. MS&T Mag. 2, 36–38 (2003)
- [124] J.T. Viitasalo, P. Era, N. Kontinen, H. Mononen, K. Mononen, K. Norvapalo, Effects of 12-week shooting training and mode of feedback on shooting scores among novice shooters. Scand. J. Med. Sci. Sports 11, 362–368 (2001)
- [125] Y. Yeh, H.Z. Cummins, Localized fluid flow measurements with an He-Ne laser spectrometer. Appl. Phys. Lett. 4, 176 (1964)
- [126] H.E. Albrecht, M. Borys, N. Damaschke, C. Tropea, *Laser Doppler and Phase Doppler Measurement Techniques* (Springer, Berlin, 2003)
- [127] R.J. Adrian (ed.), *Selected Papers on Laser Doppler Velocimetry*, SPIE MS78 Bellingham (1993)
- [128] R.J. Adrian (ed.), *Laser Techniques and Applications in Fluid Mechanics* (Springer, London, 1996)
- [129] Yu.N. Dubnistchev, B.S. Rinkevichyus (eds.), *Optical methods of flow investigation*. SPIE 6262 (2006)
- [130] H. Nobach, Analysis of dual-burst laser Doppler signals. Meas. Sci. Technol. 13, 33–44 (2002)
- [131] L. Büttner, J. Czarske, Passive directional discrimination in Laser-Doppler Anemometry by the two-wavelength quadrature homodyne technique. Appl. Opt. 42, 3843–3852 (2003)
- [132] P.J. Cronin, C.J. Cogswell, Minimum theoretical requirements for three-dimensional scanning-laser doppler anemometry. Appl. Opt. 39, 6350–6359 (2000)
- [133] E.-J. Nijhof, W.S.J. Uijtewaal, R.M. Heethaar, Blood particle distributions accessed by microscopic laser Doppler velocimetry. Proc. SPIE 2052, 187–194 (1993)
- [134] L. Büttner, J. Czarske, A multimode-fibre laser-Doppler anemometer for highly spatially resolved velocity measurements using low-coherence light. Meas. Sci. Technol. 12, 1891–1903 (2001)

- [135] K. Shirai, T. Pfister, L. Böttner, J. Czarske, H.Müller, S. Becker, H. Lienhart, F. Durst, Highly spatially resolved velocity measurements of a turbulent channel flow by a fiber-optic heterodyne laser-Doppler velocity-profile sensor. *Exp. Fluids* 40, 473–481 (2006)
- [136] T. Pfister, L. Böttner, K. Shirai, J. Czarske, Monochromatic heterodyne fiberoptic profile sensor for spatially resolved velocity measurements with frequency division multiplexing. *Appl. Opt.* 44, 2501–2510 (2005)
- [137] K. Shirai, T. Pfister, L. Böttner, J. Czarske, H.Müller, S. Becker, H. Lienhart, F. Durst, Highly spatially resolved velocity measurements of a turbulent channel flow by a fiber-optic heterodyne laser-Doppler velocity-profile sensor. *Exp. Fluids* 40, 473–481 (2006)
- [138] V.M. Gordienko, A.A. Kormakov, L.A. Kosovsky, N.N. Kurochkin, G.A. Pogosov, A.V. Priezhev, Yu. Ya Putivskii, Coherent CO₂ lidars for measuring wind velocity and atmospheric turbulence. *Opt. Eng.* 33(10), 3206–3213 (1994)
- [139] C. Werner, Applications of space-borne Doppler and backscatter lidar: a critical review. *Opt. Eng.* 34(11), 3103–3114 (1995)
- [140] S. Rahm, Measurement of a wind field with an air-borne continuous-wave Doppler lidar. *Opt. Lett.* 20, 216–218 (1995)
- [141] Galletti, E. Stucchi, D.V. Willetts, M.R. Harris, Transverse-mode selection in apertured super-Gaussian resonators: an experimental and numerical investigation for a pulsed CO₂ Doppler lidar transmitter. *Appl. Opt.* 36, 1269–1277 (1997)
- [142] T.J. Kane, W.J. Kozlovsky, R.L. Byer, C.E. Byvik, Coherent laser radar at 1.06 μm using Nd:YAG lasers. *Opt. Lett.* 12, 239–241 (1987)
- [143] V.M. Gordienko, A.N. Kononov, N.V. Kravtsov, Yu. Ya Putivskii, V.I. Savin, V.V. Firsov, Remote Doppler velocimeter based on an Nd³⁺:YAG chip laser and its application in a study of laser-induced hydrodynamic flows. *Quant. Electron.* 28(9), 827–830 (1998)
- [144] K. Otsuka, Ultrahigh sensitivity laser Doppler velocimetry with a microchip solid-state laser. *Appl. Opt.* 33, 1111–1114 (1994)
- [145] C.J. Karlsson, F. Å.A. Olsson, D. Letalick, M. Harris, All-fiber multifunction continuous-wave coherent laser radar at 1.55 μm for range, speed, vibration, and wind measurements. *Appl. Opt.* 39, 3716–3726 (2000)
- [146] M. Harris, G.N. Pearson, K.D. Ridley, C.J. Karlsson, F. Å.A. Olsson, D. Letalick, Single-particle laser Doppler anemometry at 1.55 μm. *Appl. Opt.* 40, 969–973 (2001)
- [147] M. Harris, G. Constant, C. Ward, Continuous-wave bistatic laser Doppler wind sensor. *Appl. Opt.* 40, 1501–1506 (2001)
- [148] G.J. Koch, J.Y. Beyon, B.W. Barnes, M. Petros, J. Yu, F. Amzajerdian, M.J. Kavaya, U.N. Singh, High-energy 2 μm Doppler lidar for wind measurements. *Opt. Eng.* 46(11), 116201 (2007)
- [149] R.V. Mustasich, B.R. Ware, A study of protoplasmic streaming in *Nitella* by laser Doppler spectroscopy. *Biophys. J.* 16, 373–388 (1976)

- [150] R.V. Mustasich, D.B. Sattelle, P.B. Buchan, Cytoplasmic streaming in *Chara corallina* studied by laser light scattering. *J. Cell. Sci.* 22(3), 633–643 (1976)
- [151] Ackers, Z. Hejnowicz, A. Sievers, Variation in velocity of cytoplasmic streaming and gravity effect in characean internodal cells measured by laser-Doppler-velocimetry. *Protoplasma* 179(1–2), 61–71 (1994)
- [152] Ackers, B. Buchen, Z. Hejnowicz, A. Sievers, The pattern of acropetal and basipetal cytoplasmic streaming velocities in *Chara* rhizoids and protonemata, and gravity effect on the pattern as measured by laser-Doppler-velocimetry. *Planta* 211(1), 133–143 (2000)
- [153] Yu.A. Denisov, A.S. Stepanian, A.V. Priezzhev, Laser Doppler spectroscopy of blood flow. *Moscow Univ. Phys. Bull. Ser. 3*, 30, 62–66 (1989)
- [154] A.V. Priezzhev, A.S. Stepanian, Peculiarities of blood flow velocity measurement in thin capillaries and possibilities of laser methods. *Laser Med.* 1, 31–34 (1997)
- [155] S.E. Skipetrov, R. Maynard, Dynamic multiple scattering of light in multilayer turbid media. *Phys. Lett. A* 217, 181–185 (1996)
- [156] S.E. Skipetrov, I.V. Meglinsky, Wave-diffusion spectroscopy in randominhomogenous media with local streams of scattering particles. *J. Exp. Theor. Phys.* 113, 1213–1222 (1998)
- [157] A.V. Priezzhev, M.S. Polyakova, K.B. Begun, K. Vanag, A.F. Pogrebnaya, Dual-beam laser Doppler microscopy of suspension flows embedded into medium with strong scattering. *Proc. SPIE* 3915, 129–136 (2000)
- [158] X.J. Wang, T.E. Milner, J.S. Nelson, Characterization of fluid flow velocity by optical Doppler tomography. *Opt. Lett.* 20, 1337–1339 (1995)
- [159] J.A. Izatt, M.D. Kulkarni, S. Yazdanfar, J.K. Barton, A.J. Welch, In vivo bidirectional color Doppler flow imaging of picoliter blood volumes using optical coherence tomography. *Opt. Lett.* 22, 1439–1441 (1997)
- [160] Z. Chen, T.E. Milner, D. Dave, J.S. Nelson, Optical Doppler tomography imaging of fluid flow velocity in highly scattering media. *Opt. Lett.* 22, 64–66 (1997)
- [161] Y. Zhao, Z. Chen, C. Saxer, S. Xiang, J.F. de Boer, J.S. Nelson, Phase resolved optical coherence tomography and optical Doppler tomography for imaging blood flow in human skin with fast scanning speed and high velocity sensitivity. *Opt. Lett.* 25, 114–116 (2000)
- [162] J. Hast, T. Pyykari, E. Alarousu, R. Myllylä, A.V. Priezzhev, Flow imaging and velocity measurement of highly scattering liquid inside scattering media using Doppler optical coherence tomography. *Proc. SPIE* 4965, 66–72 (2003)
- [163] X.J. Wang, T.E. Milner, Z. Chen, J.S. Nelson, Measurement of fluid-flow velocity profile in turbid media by the use of optical Doppler tomography. *Appl. Opt.* 36(1), 144–149 (1997)
- [164] S.G. Proskurin, Y. He, R.K. Wang, Doppler optical coherence imaging of converging flow. *Phys. Med. Biol.* 49(7), 1265–1276 (2004)

- [165] M. Bonesi, D. Churmakov, I. Meglinski, Study of flow dynamics in complex vessels using Doppler optical coherence tomography. *Meas. Sci. Technol.* 18, 3279–3286 (2007)
- [166] S.G. Proskurin, Y. He, R.K.Wang, Determination of flow velocity vector based on Doppler shift and spectrum broadening with optical coherence tomography. *Opt. Lett.* 28, 1227–1229 (2003)
- [167] R.K. Wang, High-resolution visualization of fluid dynamics with Doppler optical coherence tomography. *Meas. Sci. Technol.* 15, 725–733 (2004)
- [168] T. Lindmo, D.J. Smithies, Z. Chen, J.S. Nelson, T.E. Milner, Accuracy and noise in optical Doppler tomography studied by Monte Carlo simulation. *Phys. Med. Biol.* 43, 3045–3064 (1998)
- [169] A.V. Bykov, M.Yu. Kirillin, A.V. Priezzhev, Monte Carlo simulation of an optical coherence Doppler tomograph signal: the effect of the concentration of particles in a flow on the reconstructed velocity profile. *Quant. Electron.* 35(2), 135–139 (2005)
- [170] A.V. Bykov, M. Yu. Kirillin, A.V. Priezzhev, Analysis of distortions in the velocity profiles of suspension flows in a light-scattering medium upon their reconstruction from the optical coherence Doppler tomograph signal. *Quant. Electron.* 35(11), 1079–1082 (2005)
- [171] J. Moger, S.J. Matcher, C.P. Winlove, A. Shore, The effect of multiple scattering on velocity profiles measured using Doppler OCT. *J. Phys. D: Appl. Phys.* 38, 2597–2605 (2005)
- [172] J. Seki, Y. Satomura, Y. Ooi, T. Yanagida, A. Seiyama, Velocity profiles in the rat cerebral microvessels measured by optical coherence tomography. *Clin. Hemorheol. Microcirc.* 34(1–2), 233–239 (2006)
- [173] S. Yazdanfa, A.M. Rollins, J.A. Izatt, In vivo imaging of human retinal flow dynamics by color Doppler optical coherence tomography. *Arch. Ophthalmol.* 121, 235–239 (2003)
- [174] B.R. White, M.C. Pierce, N. Nassif, B. Cense, B.H. Park, G.J. Tearney, B. Bouma, T.C. Chen, J.F. de Boer, In vivo dynamic human retinal blood flow imaging using ultra-high-speed spectral domain optical Doppler tomography. *Opt. Express* 11, 3490–3497 (2003)
- [175] M. Wojtkowski, V.J. Srinivasan, T.H. Ko, J.G. Fujimoto, A. Kowalczyk, J.S. Duker, Ultrahigh-resolution, high-speed, Fourier domain optical coherence tomography and methods for dispersion compensation. *Opt. Express* 12, 2404–2422 (2004)
- [176] Y. Zhao, Z. Chen, C. Saxer, Q. Shen, S. Xiang, J.F. de Boer, J.S. Nelson, Doppler standard deviation imaging for clinical monitoring of in vivo human skin blood flow. *Opt. Lett.* 25, 1358–1360 (2000)
- [177] Y. Wang, B.A. Bower, J.A. Izatt, O. Tan, D. Huang, In vivo total retinal blood flow measurement by Fourier domain Doppler optical coherence tomography. *J. Biomed. Opt.* 12(4), 041215 (2007)

- [178] H. Ren, T. Sun, D.J. MacDonald, M.J. Cobb, X. Li, Real-time in vivo bloodflow imaging by moving-scatterer-sensitive spectral-domain optical Doppler tomography. *Opt. Lett.* 31(7), 927–929 (2006)
- [179] V.X. Yang, Y.X. Mao, N. Munce, B. Standish, W. Kucharczyk, N.E. Marcon, B.C. Wilson, A.I. Vitkin, Interstitial Doppler optical coherence tomography. *Opt Lett.* 30(14), 1791–1793 (2005)
- [180] H. Li, B.A. Standish, A. Mariampillai, N.R. Munce, Y. Mao, S. Chiu, N.E. Marcon, B.C. Wilson, A.I. Vitkin, V.X. Yang, Feasibility of interstitial Doppler optical coherence tomography for in vivo detection of microvascular changes during photodynamic therapy. *Lasers Surg. Med.* 38(8), 754–761 (2006)
- [181] B.A. Standish, X. Jin, J.A. Smolen, A. Mariampillai, N.R. Munce, B.C. Wilson, A.I. Vitkin, V.X. Yang, Interstitial Doppler optical coherence tomography monitors microvascular changes during photodynamic therapy in a Dunning prostate model under varying treatment conditions. *J. Biomed. Opt.* 12(03), 034022 (2007)
- [182] V.X.D. Yang, Y. Mao, B.A. Standish, N.R. Munce, S. Chiu, D. Burnes, B.C. Wilson, I.A. Vitkin, P.A. Himmer, D.L. Dickensheets, Doppler optical coherence tomography with a micro-electro-mechanical membrane mirror for high-speed dynamic focus tracking. *Opt. Lett.* 31, 1262–1264 (2006)
- [183] V.X. Yang, S.J. Tang, M.L. Gordon, B. Qi, G. Gardiner, M. Cirocco, P. Kortan, G.B. Haber, G. Kandel, A.I. Vitkin, B.C. Wilson, N.E. Marcon, Endoscopic Doppler optical coherence tomography in the human GI tract: initial experience. *Gastrointest. Endosc.* 61(7), 879–890 (2005)
- [184] M.D. Kulkarni, T.G. van Leeuwen, S. Yazdanfar, J.A. Izatt, Velocity estimation accuracy and frame-rate limitations in color Doppler optical coherence tomography. *Opt. Lett.* 23(13), 1057–1059 (1998)
- [185] M.A. Choma, A.K. Ellerbee, S. Yazdanfar, J.A. Izatt, Doppler flow imaging of cytoplasmic streaming using spectral domain phase microscopy. *J. Biomed. Opt.* 11(2), 024014 (2006)
- [186] A.K. Ellerbee, H.C. Hendargo, A.R. Motomura, J.A. Izatt, Extension of spectral domain phase microscopy to three-dimensional nanoscale displacement mapping in cardiomyocytes. *Proc. SPIE* 6861, 686108 (2008)
- [187] A.P. Shepherd, P.A. Oberg (eds.), *Laser-Doppler Blood Flowmetry* (Kluwer, Hingham, MA, 1990)
- [188] W. Steenbergen, R. Kolkman, F. de Mul, Light-scattering properties of undiluted human blood subjected to simple shear. *J. Opt. Soc. Am. A* 16, 2959–2967 (1999)
- [189] A.N. Yaroslavsky, A.V. Priezzhev, J. Rodrigues, I.V. Yaroslavsky, H. Battarbee, Optics of blood, in *Handbook on Optical Biomedical Diagnostics*, ed. By V.V. Tuchin (SPIE Press, Bellingham, 2002), pp. 169–216
- [190] F.F.M. de Mul, M.H. Koelink, M.L. Kok, P.J. Harmsma, J. Greve, R. Graaff, J.G. Aarnoudse, Laser Doppler velocimetry and Monte Carlo simulations on models for blood perfusion in tissue. *Appl. Opt.* 34, 6595–6611 (1995)

- [191] Y. Watanabe, E. Okada, Influence of perfusion depth on laser Doppler flow measurements with large source-detector spacing. *Appl. Opt.* 42, 3198–3204 (2003)
- [192] M. Bracic, A. Stefanovska, Wavelet-based analysis of human blood-flow dynamics. *Bull. Math. Biol.* 60(5), 919–935 (1998)
- [193] Stefanovska, M. Bracic, H.D. Kvernmo, Wavelet analysis of oscillations in the peripheral blood circulation measured by laser Doppler technique. *IEEE Trans. Biomed. Eng.* 46(10), 1230–1239 (1999)
- [194] Serov, B. Steinacher, T. Lasser, Full-field laser Doppler blood-flow imaging and monitoring using an intelligent CMOS camera and area illumination. *Opt. Express* 13(10), 3681–3689 (2005)
- [195] Serov, T. Lasser, High-speed laser Doppler perfusion imaging using an integrating CMOS image sensor. *Opt. Express* 13(17), 6416–6428 (2005)
- [196] E.R. Fossum, CMOS image sensors: electronic camera-on-a-chip. *IEEE Trans. Electron. Devices* 44, 1698–1698 (1997)
- [197] V.G. Kolinko, F.F.M. de Mul, J. Greve, A.V. Priezzhev, Feasibility of picoseconds laser-Doppler flowmetry provides basis for time-resolved tomography of biological tissue. *J. Biomed. Opt.* 3(2), 187–190 (1998)
- [198] S. Monstrey, H. Hoeksema, J. Verbelen, A. Pirayesh, P. Blondeel, Assessment of burn depth and burn wound healing potential. *Burns* 34(6), 761–769 (2008)
- [199] M. Atlan, B.C. Forget, A.C. Boccara, T. Vitalis, A. Rancillac, A.K. Dunn, Cortical blood flow assessment with frequency-domain laser Doppler microscopy. *J. Biomed. Opt.* 12(2), 024019 (2007)
- [200] R.K. Wang, S. Hurst, Mapping of cerebro-vascular blood perfusion in mice with skin and skull intact by Optical Micro-AngioGraphy at 1.3 μm wavelength. *Opt. Express* 15(18), 11402–11412 (2007)
- [201] R.K. Wang, Directional blood flow imaging in volumetric optical microangiography achieved by digital frequency modulation. *Opt. Lett.* 33(16), 1878–1880 (2008)
- [202] R.K. Wang, S.L. Jacques, Z. Ma, S. Hurst, S.R. Hanson, A. Gruber, Three dimensional optical angiography. *Opt. Express* 15(7), 4083–4097 (2007)
- [203] R.K. Wang, Three dimensional optical angiography maps directional blood perfusion deep within microcirculation tissue beds in vivo. *Phys. Med. Biol.* 52, N531–N537 (2007)
- [204] L. An, R.K. Wang, In vivo volumetric imaging of vascular perfusion within human retina and choroids with optical micro-angiography. *Opt. Express* 16(15), 11438–11452 (2008)
- [205] T.J. Mueller, The 11th International symposium on flow visualization. *J. Visual.* 8(2), 187–191 (2005)
- [206] J. Kompenhans, The 12th International symposium on flow visualization. *J. Visual.* 10(1), 123–128 (2007)
- [207] Grant, Electronic proceedings editor, Proceedings of ISFV-12 (2006),
- [208] Optimage Ltd., Edinburgh, UK, CD ROM I. Grant (ed.), *Selected Papers on Particle Image Velocimetry*, SPIE MS99, Bellingham (1994)

- [209] J. Westerweel, Fundamentals of digital particle image velocimetry. *Meas. Sci. Technol.* 8, 1379–1392 (1997)
- [210] A.J. Prasad, Particle image velocimetry. *Current Sci.* 79, 51–57 (2000)
- [211] R.J. Adrian, Twenty years of particle image velocimetry, in *Proceedings of 12th International Symposium on Applications of Laser Techniques to Fluid Mechanics*, Lisbon, July 12–15 (2004)
- [212] K.S. Breuer (ed.), *Microscale Diagnostic Techniques* (Springer, New-York, 2005)
- [213] M. Raffel, C.E. Willert, S.T. Wereley, J. Kompenhans, *Particle Image Velocimetry: A Practical Guide*, 2nd ed. (Springer, Berlin, 2007)
- [214] Melling, Tracer particles and seeding for particle image velocimetry. *Meas. Sci. Technol.* 8, 1406–1416 (1997)
- [215] A.J. Prasad, Particle image velocimetry. *Current Sci.* 79, 51–57 (2000)
- [216] R. Meynart, *Particle Image Displacement Velocimetry* (1980), part of the Von Karman Institute for Fluid Dynamics lecture series, March 21–25 (1988)
- [217] P.J. Bryanston-Cross, T.R. Judge, C. Quan, G. Pugh, N. Corby, The application of digital particle image velocimetry (DPIV) to transonic flows. *Prog. Aerospace Sci.* 31, 273–290 (1995)
- [218] C.M. Zettner, M. Yoda, A novel interfacial velocimetry technique with submicron spatial resolution. *54th Annual Meeting of the Division of Fluid Dynamicsof American Physical Society*, November 18–20, San Diego, CA, USA (2001)
- [219] M.L. Smith, D.S. Long, E.R. Damiano, K. Ley, Near-wall micro-PIV reveals a hydrodynamically relevant endothelial surface layer in venules in vivo. *Biophys. J.* 85(1), 637–645 (2003)
- [220] J.Y. Lee, H.S. Ji, S.J. Lee, Micro-PIV measurements of blood flow in extraembryonic blood vessels of chicken embryos. *Physiol. Meas.* 28(10), 1149–1162 (2007)
- [221] Y. Sugii, S. Nishio, K. Okamoto, Measurement of a velocity field in microvessels using a high resolution PIV technique. *Ann. N. Y. Acad. Sci.* 972, 331–336 (2002)
- [222] Nakano, Y. Sugii, M. Minamiyama, H. Niimi, Measurement of red cell velocity in microvessels using particle image velocimetry (PIV). *Clin. Hemorheol. Microcirc.* 29(3–4), 445–455 (2003)
- [223] A.M. Fallon, L.P. Dasi, U.M. Marzec, S.R. Hanson, A.P. Yoganathan, Procoagulant properties of flow fields in stenotic and expansive orifices. *Ann. Biomed. Eng.* 36(1), 1–13 (2008)
- [224] R. Kaminsky, U. Morbiducci, M. Rossi, L. Scalise, P. Verdonck, M. Grigioni, Time-resolved PIV technique for high temporal resolution measurement of mechanical prosthetic aortic valve fluid dynamics. *J. Artif. Organs* 30(2), 153–162 (2007)
- [225] H.B. Kim, J. Hertzberg, C. Lanning, R. Shandas, Noninvasive measurement of steady and pulsating velocity profiles and shear rates in arteries using echo PIV: in vitro validation studies. *Ann. Biomed. Eng.* 32(8), 1067–1076 (2004)

- [226] Sinton, Microscale flow visualization. *Microfluid. Nanofluid.* 1(1), 2–21 (2004)
- [227] R. Lima, S. Wada, M. Takeda, K. Tsubota, T. Yamaguchi, In vitro Confocal micro-PIV measurements of blood flow in a square microchannel: the effect of the haematocrit on instantaneous velocity profiles. *J. Biomech.* 40(12), 2752–2757 (2007)
- [228] R. Lima, S. Wada, S. Tanaka, M. Takeda, T. Ishikawa, K. Tsubota, Y. Imai, T. Yamaguchi, In vitro blood flow in a rectangular PDMS microchannel: experimental observations using a confocal micro-PIV system. *Biomed. Microdev.* 10(2), 153–167 (2008)
- [229] H. Kinoshita, S. Kaneda, T. Fujii, M. Oshima, Three-dimensional measurement and visualization of internal flow of a moving droplet using confocal micro-PIV. *Lab Chip.* 7(3), 338–346 (2007)
- [230] N. N'ève, J.K. Lingwood, J. Zimmerman, S.S. Kohles, D.C. Tretheway, The μ PIVOT: an integrated particle image velocimeter and optical tweezers instrument for microenvironment investigations. *Meas. Sci. Technol.* 19 095403 (2008)
- [231] K.D. Hinsch, Holographic particle image velocimetry. *Meas. Sci. Technol.* 13(7) R61 (2002)
- [232] K.D. Hinsch, S.F. Herrmann, Holographic particle image velocimetry. *Meas. Sci. Technol.* 15(4) (2004)
- [233] H. Meng, G. Pan, Y. Pu, S.H. Woodward, Holographic particle image velocimetry: from film to digital recording. *Meas. Sci. Technol.* 15(4), 673–685 (2004)
- [234] Malkiel, J.N. Abras, J. Katz, Automated scanning and measurements of particle distributions within a holographic reconstructed volume. *Meas. Sci. Technol.* 15(4), 601–612 (2004)
- [235] S.F. Herrmann, K.D. Hinsch, Light-in-flight holographic particle image velocimetry for wind-tunnel applications. *Meas. Sci. Technol.* 15(4), 613–621 (2004)
- [236] R. Alcock, C.P. Garner, N.A. Halliwell, J.M. Coupland, An enhanced HPIV configuration for flow measurement through thick distorting windows. *Meas. Sci. Technol.* 15(4), 631–638 (2004)
- [237] Barnhart, W.D. Koek, T. Juchem, N. Hampp, J.M. Coupland, N.A. Halliwell, Bacteriorhodopsin as a high-resolution, high-capacity buffer for digital holographic measurements. *Meas. Sci. Technol.* 15(4), 639–646 (2004)
- [238] N. Masuda, T. Ito, K. Kayama, H. Kono, S. Satake, T. Kunugi, K. Sato, Special purpose computer for digital holographic particle tracking velocimetry. *Opt. Express* 14, 587–592 (2006)
- [239] K. Matsumoto, S. Takagi, T. Nakagaki, Locomotive mechanism of *Physarum* plasmodia based on spatiotemporal analysis of protoplasmic streaming. *Biophys. J.* 94, 2492–2504 (2008)
- [240] S.A. Japee, C.G. Ellis, R.N. Pittman, Flow visualization tools for image analysis of capillary networks. *Microcirc.* 11(1), 39–54 (2004)

- [241] M. Cutolo, C. Pizzorni, A. Sulli, Nailfold video-capillaroscopy in systemic sclerosis. *Z. Rheumatol.* 63(6), 457–462 (2004)
- [242] Yu. Gurfinkel, Computer capillaroscopy as a channel of local visualization, noninvasive diagnostics, and screening of substances in circulating blood. *Proc. SPIE* 4241, 467–472 (2001)
- [243] Yu.I. Gurfinkel, V.M. Mikhailov, New potentialities for noninvasive optical investigation of microcirculation in extended space missions. *Proc. SPIE* 4624, 134–138 (2002)
- [244] Yu.I. Gurfinkel, V.M. Mikhailov, M.I. Kudutkina, Noninvasive estimation of tissue edema in healthy volunteers and in patients suffering from heart failure. *Proc. SPIE* 5325, 150–156 (2004)
- [245] A.A. Parthasarathi, S.A. Japee, R.N. Pittman, Determination of red blood cell velocity by video shuttering and image analysis. *Ann. Biomed. Eng.* 27(3), 313–325 (1999)
- [246] Chaigneau, M. Oheim, E. Audinat, S. Charpak, Two-photon imaging of capillary blood flow in olfactory bulb glomeruli. *Proc. Natl Acad. Sci. Am.* 100(22), 13081–13086 (2003)
- [247] K. Tsukada, H. Minamitani, E. Sekizuka, C. Oshio, Image correlation method for measuring blood flow velocity in microcirculation: correlation ‘window’ simulation and in vivo image analysis. *Physiol. Meas.* 21, 459–471 (2000)
- [248] Mchedlishvili, Disturbed blood flow structuring as critical factor of hemorheological disorders in microcirculation. *Clin Hemorheol. Microcirc.* 19(4), 315–325 (1998)