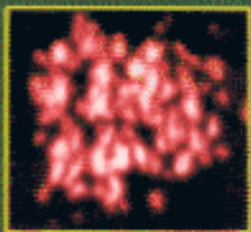


TISSUE OPTICS

**Light Scattering Methods and
Instruments for Medical Diagnosis**



Valery Tuchin

CONTENTS

NOMENCLATURE	ix
ACRONYMS	xix
PREFACE	xxi

Part I. AN INTRODUCTION TO TISSUE OPTICS

1. Optical Properties of Tissues with Strong (Multiple) Scattering	3
1.1 Propagation of continuous wave light in tissues	3
1.1.1 Basic principles and major absorbers	3
1.1.2 Theoretical description	6
1.1.3 Monte Carlo simulation techniques	11
1.2 Methods for measurement of the optical parameters of tissues	15
1.2.1 Basic principles	15
1.2.2 Methods and results	17
1.2.3 Direct measurement of the scattering phase function	38
1.2.4 Refractive index measurements	40
1.3 Controlling optical properties of tissues	44
1.4 Short pulse propagation in tissues	49
1.4.1 Basic principles and theoretical background	49
1.4.2 Principles and instruments for time-resolved spectroscopy and imaging of tissues	52
1.4.3 Coherent backscattering	53
1.5 Diffuse photon-density waves	55
1.5.1 Basic principles and theoretical background	55
1.5.2 Principles of frequency-domain spectroscopy and imaging of tissues	59
1.6 Propagation of polarized light in tissues	62
1.7 Optothermal and optoacoustic interactions of light with tissues	75
1.8 Discrete-particle model of tissue	91
1.9 Tissue phantoms	98
2. Optical Properties of Eye Tissues	109
2.1 Optical models of eye tissues	109
2.2 Transmission and scattering spectra of eye tissues	117
2.3 Polarization properties	129

3. Coherent Effects in the Interaction of Laser Radiation with Tissues and Cell Flows	135
3.1 Formation of speckle structures	135
3.2 Interference of speckle fields	141
3.3 Propagation of spatially modulated laser beams in a scattering medium	143
3.4 Dynamic light scattering	146

Part II. LIGHT-SCATTERING METHODS AND INSTRUMENTS FOR MEDICAL DIAGNOSIS

4. CW Spectrophotometry	153
4.1 Techniques and instruments for <i>in vivo</i> spectroscopy and imaging of tissues	153
4.2 Example of a CW imaging system	157
4.3 Example of a tissue spectroscopy system	159
5. Time- and Frequency-Domain Spectroscopy and Tomography of Tissues	161
5.1 Time-domain techniques and instruments	161
5.2 Frequency-domain techniques and instruments	167
5.3 Phased-array technique	174
5.4 <i>In vivo</i> measurements, detection limits, and examples of clinical study	179
6. Coherence-Domain Methods and Instruments for Biomedical Diagnostics and Imaging	187
6.1 Photon-correlation spectroscopy of transparent tissues and cell flows	187
6.2 Diffusion-wave spectroscopy and interferometry: measurement of blood microcirculation	192
6.3 Interferometric and speckle-interferometric methods for the measurement of biovibrations	199
6.4 Optical speckle topography and tomography of tissues	205
6.5 Methods of coherent microscopy	219
6.6 Partial-coherence interferometry and tomography	226
6.7 Optical heterodyne imaging	236

CONCLUSION	243
----------------------	-----

GLOSSARY 1. PHYSICS, STATISTICS, AND ENGINEERING	245
Sources	278

GLOSSARY 2. MEDICINE, BIOLOGY, AND CHEMISTRY	279
Sources	310

REFERENCES	311
----------------------	-----

INDEX	349
-----------------	-----