

SPECIAL SECTION GUEST EDITORIAL

Cardiovascular Photonics

Cardiovascular diseases are responsible for the major causes of death in developed countries and include disorders of the heart and blood vessels (coronary, cerebral, peripheral, and visceral) such as arrhythmias, myocardial ischemia, atherosclerosis, restenosis, thrombosis, pathologic vascular remodeling, aneurysms, oxidative stress, and inflammatory processes. In the past decade, diverse optical spectroscopy and imaging techniques and laser technologies have been engineered and are currently being used to analyze atherosclerotic plaque composition, morphology, and inflammatory activity, to study cardiac electrophysiological properties, and to enable ablative processes for transmural revascularization, therapy of arrhythmias, and thrombolysis. In addition, recent advances in molecular-targeted imaging agents in conjunction with novel noninvasive imaging techniques have provided unique opportunities for studying normal and pathologic processes less invasively at the molecular and cellular levels, for understanding cardiovascular pathologies and for monitoring the effectiveness of therapies.

The goal of this special section is to provide an update on the current status of the state-of-the-art photonic methods and technologies to research, diagnose, and treat cardiovascular diseases. Although not all optical techniques are encompassed here, this section musters timely optical approaches for diagnostic of atherosclerotic plaques with particular emphasis on detection of vulnerable or high-risk plaques. This includes optical coherence tomography (Tearney et al.), Raman spectroscopy (Motz et al.), fluorescence spectroscopy (Jo et al.), reflection spectroscopy (Lilledahl et al.), and laser speckle imaging (Nadkarni et al.). A multimodal spectroscopy approach that combines reflectance, fluorescence and Raman spectroscopy is described by Scepanovic et al. The papers by Tawakol et al. and Pande et al. report detection of macrophage and macrophage activity, important markers of plaque vulnerability, through molecular-targeted methods. Atherosclerotic plaque rupture is the main cause of acute syndromes comprising unstable angina, myocardial infarction, stroke, and sudden death. The results reported here demonstrate the potential of

these optical techniques for detection of structural and compositional features associated with plaque vulnerability.

Research work toward the development of optical biosensors is reported by Jeetender et al. for monitoring acute myocardial infarction and by Tang et al. for simultaneous quantification of multi-biomarkers in plasma blood.

Techniques for studying and controlling therapeutic interventions in cardiovascular pathologies are reported in two papers. Lu et al. report an optical-mapping technique for studying the production of reactive oxygen species production in myocardium throughout global ischemia reperfusion, while Ravi et al. describe an optical-recording method for controlling the delivery and optimization of low-energy ventricular defibrillation.

The last two papers in this section target optical techniques that support cardiovascular research. The paper by Luo et al. shows the use of optical coherence tomography as a tool for monitoring cardiovascular development; Fujita et al. report a two-laser beam interference technique for controlling cardiomyocyte orientation on microscaffolds.

It is our hope that this special section on cardiovascular photonics will prove useful to the biomedical community and will assist in the translation of optical sciences and engineering to the clinic and the development of new tools for cardiovascular biology research.

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