

Hard Tissue Optics and Related Methods

We are very pleased to present this special section of the *Journal of Biomedical Optics* on hard tissue optics. Recent developments in lasers and other photonic technologies have enabled novel therapeutic and diagnostic applications targeted towards hard tissues. The chemical, structural, and mechanical properties of calcified tissues vary markedly from those of other biological tissues, leading to fundamentally different optical behavior. The differences are on display in the 10 papers included here. They report advances in dentistry (eight papers), urology (one paper), and orthopaedics (one paper).

Several optical imaging methods have been recently introduced for the detection of dental decay. There are four papers that report optical methods for the detection of dental caries; one of those reports fluorescence, two report thermophotonic imaging, and the fourth reports optical coherence tomography (OCT). New diagnostic tools are needed for the detection and characterization of caries lesions in the early stages of development when the caries process is potentially preventable and curable. The paper by Zhang et al. discusses mechanisms for the observed red shift in fluorescence with excitation wavelength between 400 to 532 nm. Analysis of the thermal emission from tooth surfaces can provide information about the depth and severity of natural and simulated caries lesions and there are two papers by Tabatabaei et al. and Hellen et al. employing thermophotonic lock-in imaging and photothermal radiometry to acquire images of caries lesions and monitor early demineralization. Optical coherence tomography can be used for imaging early dental decay and Natsume et al. show that OCT can be used to monitor the severity of demineralization on the surfaces of tooth roots.

Lasers are well suited for the selective removal of dental decay and in a paper by Nguyen et al. the thermal effects of a CO₂ laser operating at high pulse repetition rates are

discussed. Lasers can also be used for caries prevention by thermally modifying the chemical composition of dental enamel to render the outer surface of the tooth more resistant to acid dissolution. In the *in vivo* study of Rechmann et al. a CO₂ laser was employed.

Two papers involve dental calculus. The study of Sun et al. involves the use of OCT for imaging calculus while in the study of Schoenly et al. a Ti:sapphire laser is used for its selective removal.

Raman, infrared, fluorescence, and other spectroscopic techniques can be used for measuring chemical composition changes in hard tissues. The paper of McElderry et al. reports tissue storage conditions for obtaining valid Raman spectra for bone quality measurements.

In addition to cutting bone and removing dental decay, high-power lasers can be used for the fragmentation of kidney stones. The paper by Blackmon et al. demonstrates the use of high-power fiber lasers for lithotripsy.

We hope these papers in this special section will be of interest to many researchers in the field of biophotonics and will spur them to join the community of scientists and engineers who already have a specific interest in hard tissues.

Daniel Fried

University of California, San Francisco

Andreas Mandelis

University of Toronto

Michael Morris

University of Michigan

Special Section Guest Editors