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Experimental investigation on the caries characteristic of dental tissues by photothermal radiometry scanning imaging

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Abstract. In this paper, a one-dimensional (1D) thermal-wave model coupled diffuse-photon-density-wave for three-layer dental tissues using modulated laser stimulation was employed to illustrate the relationship between dental caries characteristic (i.e. caries layer thickness, optical absorption coefficient and optical scattering coefficient) and photothermal radiometry (PTR) signal. Experimental investigation of artificial caries was carried out using PTR scanning imaging. The PTR amplitude and phase delay were increased with dental demineralized treatment. The local caries characteristic parameters were obtained by the best-fitting method based on the 1D thermal-wave model. The PTR scanning imaging measurements illustrated that the optical absorption coefficient and scattering coefficient of caries region were much higher than those of the healthy enamel area. The demineralization thickness of caries region was measured by PTR scanning imaging and its average value shows in good agreement with the digital microscope. Experimental results show that PTR scanning imaging has the merits of high contrast for local inhomogeneity of dental caries; furthermore, this method is an allowance to provide a flexibility for non-contact quantitative evaluation of dental caries.

Keywords: thermal-wave model, photothermal physics parameters, PTR scanning imaging, biological tissues

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1. Introduction

Caries, a kind of common oral cavity diseases, is considered to be induced by three factors (Bacteria, host and environment). The progression of caries can be divided into enamel caries, superficial caries of dentin and deep caries [1]. Preventive action, such as fluoride therapy, can be used to prevent deterioration or even remineralize the caries at the early stage (enamel caries) [2]. If the enamel caries is not detected in time, it will continue to deteriorate to a second stage.