Superficial and In-depth Images of a Biological Sample Using Photopyroelectric Microscopy

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Abstract. The use of a photopyroelectric technique to obtain superficial and in-depth images, by means of the interaction of thermal waves with the analyzed sample, has reached great interest due to its applications. In this paper we use photopyroelectric microscopy to obtain superficial and in-depth images of a dental piece. In the experimental setup a pyroelectric sensor and linear micro-positioners were used to obtain the photopyroelectric signal in each point of the sample which varies depending of the local, optical, and thermal, characteristics. Then it is possible by scanning the sample to obtain an image that reflects these local features.

INTRODUCTION

By using thermal waves it is possible to obtain a non-destructive evaluation of various types of surface and subsurface features in a sample. In thermal–wave imaging thermal characteristics, on or beneath the surface, of a sample can be detected. Thermal features are those regions of a material that exhibit thermal variations, relative to their surroundings. Imaging of local thermal features requires detection of the reflected and scattered thermal waves [1]. This detection can be done by photothermal (PT) techniques. These techniques involve the measurement of heat produced as an excited species relaxes by a nonradiative path. The excited light is modulated at a fixed frequency and the resulting modulated heat flow is detected by using some temperature sensor and a lock-in amplifier. PT techniques allow acquisition of information of samples with inherent difficulties such as structures that vary with depth or highly light-scattering materials (for example, animal tissues, vegetables, and semiconductors) [2]. Different researchers have used PT techniques to detect inhomogeneous structures such as integrated circuits [3] as well as diffused and ion-implanted regions in semiconductors [4]. The photoacoustic technique was the first PT technique used for thermal imaging. There has been interest in employing Photoacoustic Microscopy (PAM) for surface and subsurface imaging and microscopy of solid materials. PAM is a well established and useful tool in the nondestructive characterization of materials. The amplitude of the photoacoustic signal is not only directly dependent on the surface optical properties of the sample, but also on the subsurface features. However, the phase angle of the signal is mainly dependent on

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