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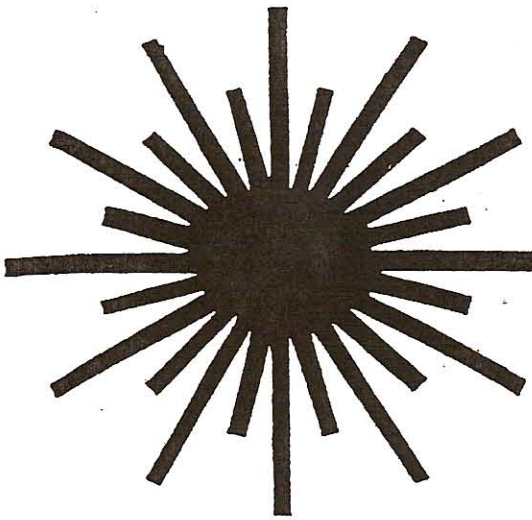

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SPECTROSCOPIC TECHNIQUES USED IN DENTAL STUDIES

Rajendra Singh

Department of Endodontics College of Dentistry
Howard University, Washington, DC 20059

LeVatrice Nora,[*] K. Sentrayan,[+] C. Haridass,[*] and P. Misra[*]

[*]Department of Physics & Astronomy and [+]Department of Neurology
Howard University, Washington, DC 20059

Abstract

Extracted virgin teeth and cariously and periodontally diseased teeth were irradiated with light in the wavelength range 200 – 1000 nm. The absorption and scattering data were compared for the different classes of extracted teeth.

Introduction

It has been known for quite some time now that teeth fluoresce when irradiated with ultraviolet (UV) light.[1] Early studies have shown that UV-irradiated teeth produce intense blue fluorescence, and dentin fluoresces much more strongly than enamel.[2] It has also been noted that white spot associated with human teeth indicative of beginning dental caries did not fluoresce. In the past, there have been two schools of thought relating to these observations. One view is that the organic protein compounds of teeth are key to the fluorescence observations. Teeth extracted with alkaline glycerol retain enough organic matter to fluoresce; however, this property is lost after treatment with hydrogen peroxide and ammonia. The second point of view stresses that the generated fluorescence is linked to the mineral phase associated with teeth. It has also been noted in the literature[2] that fluorescence is destroyed by burning up the organic content at 600-degrees. Interestingly enough, the treatment of teeth with acid, followed by precipitation with alkali, restored the fluorescence by heating to 400-degrees. Other investigators[3] have suggested that dental lymph is responsible for the fluorescence, and yet vital and non-vital teeth both fluoresce under UV-irradiation. Answers to two key questions are mired in controversy: (1) What substance(s) produce the fluorescence? (2) Why do teeth exhibit markedly less fluorescence

when afflicted with dental caries? The aim of the present study is to attempt to make some headway in answering these two key questions.

Experimental

Three classes of teeth were used in this experiment: healthy virgin teeth, cariously involved teeth, and periodontaly affected teeth. All 250 samples from patients ranging between 15 and 75 years of age were stored in the dark in 10% neutral buffered formaldehyde solution. Each tooth was cut one time sagitally with a water-cooled diamond coated band saw into a 2 mm section. Each class of teeth was stored in separately marked bottles in a dark place. Spectral scans were taken for each cut sample in the range 200 – 1000 nm with a Hitachi U-2001 UV/VIS spectrophotometer.

Results and Discussion

Table 1 is a summary of the absorption and scattering features of four teeth samples that where recorded and analyzed. Two healthy samples (#5 and #6) were virgin teeth samples that had been extracted for nerve-related pain and other surgical reasons, while the pair of infected samples (#7 and #15) had been extracted for periodontal and carious reasons. We noted both scattering and absorption in the spectral data. The effect of scattering will have to be markedly reduced in order to make reliable interpretations based on the recorded data. The UV spectrophotometer provided scans showing absorption versus wavelength. The four samples (two virgin and two infected), the solvent (formaldehyde), and the solvent together with the tooth were placed in turn in the path of the UV beam of the spectrophotometer. For samples #5 Virgin and #6 Virgin teeth (which had been extracted for orthodontic reasons), the spectral data showed absorption in the 200-380 nm range and exhibited increased absorption when the data were recorded with both the solvent and teeth. Figure 1 is a representative scan for sample #6 Virgin tooth. Figures 2 and 3 are illustrations of the absorption spectra for the solvent (formaldehyde) and the solvent together with #6 Virgin tooth, respectively. The spectral data for samples #7 Infected and #15 Infected teeth (which had been extracted for periodontal and carious reasons) also showed similar features in the 200-380 nm region. However, for sample #7 Infected tooth, the absorption was consistently higher than the virgin teeth and also more than the #15 Infected tooth (see Table 1). In addition, we noted considerable spectral saturation in the 200-450 nm region for the #7 infected (solvent & tooth) scan.

Table 1. Absorption (and Scattering) Features of Virgin and Infected Teeth in the Spectral Range 200 – 1000 nm

Sample Type	Solvent (Formaldehyde) (Range)		Tooth		Solvent & Tooth	
	Absorption	Wavelength (nm)	Absorption	Wavelength (nm)	Absorption	Wavelength (nm)
#5 Virgin	2.186 – 0.413 0.112 – 0.258	200.0 – 252.0 917.0 – 960.0	1.781 1.705 1.313 1.842	200.0 279.0 326.0 380.0	2.416 2.336 1.972 2.542	200.0 278.0 326.0 380.0
#6 Virgin	2.128 – 0.348 0.127 – 0.252	200.0 – 245.0 936.0 – 964.0	1.729 1.678 1.295 1.846	200.0 277.0 326.0 380.0	2.117 2.036 1.651 2.166	200.0 279.0 326.0 380.0
#7 Virgin	3.592 – 0.386 0.112 – 0.257	200.0 – 254.0 926.0 – 962.0	2.740 2.610 2.206 2.632	200.0 276.0 326.0 379.0	Saturation	200.0 – 450.0
#15 Infected	2.439 – 0.286 0.188 – 0.309	200.0 – 315.0 937.0 – 962.0	1.789 1.729 1.352 1.884	200.0 275.0 327.0 380.0	2.690 2.518 2.176 2.601	200.0 282.0 327.0 380.0

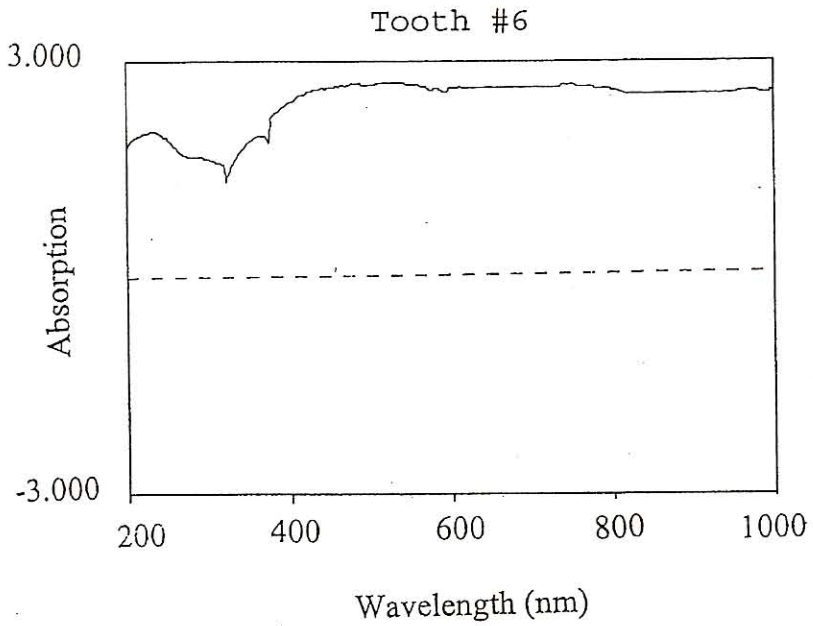

Fig. 1. The plot shows the absorption (and scattering) spectral features observed for the Virgin tooth #6 sample in the 200 – 1000 nm region.

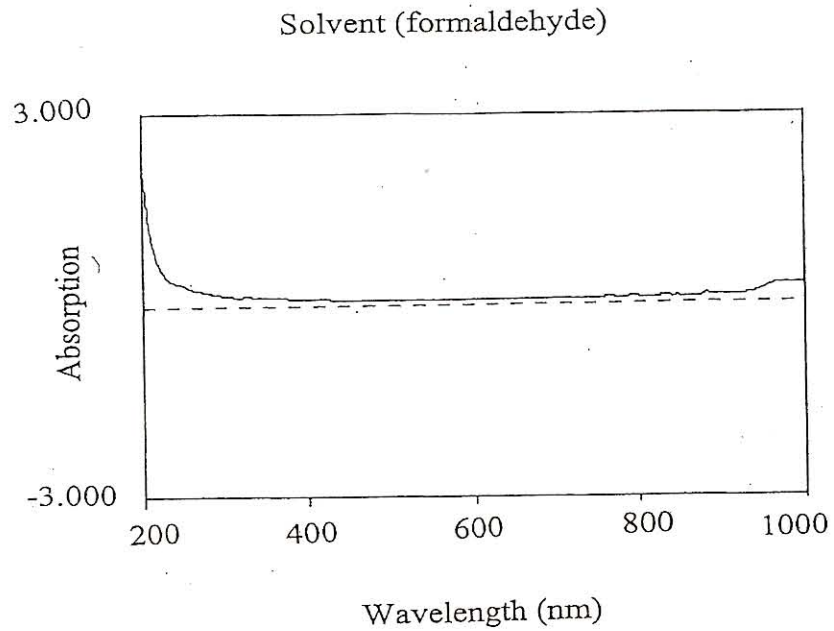

Fig. 2. The plot exhibits the absorption (and scattering) in the 200 – 1000 nm region exhibited by the Solvent (formaldehyde) used to store Virgin tooth #6

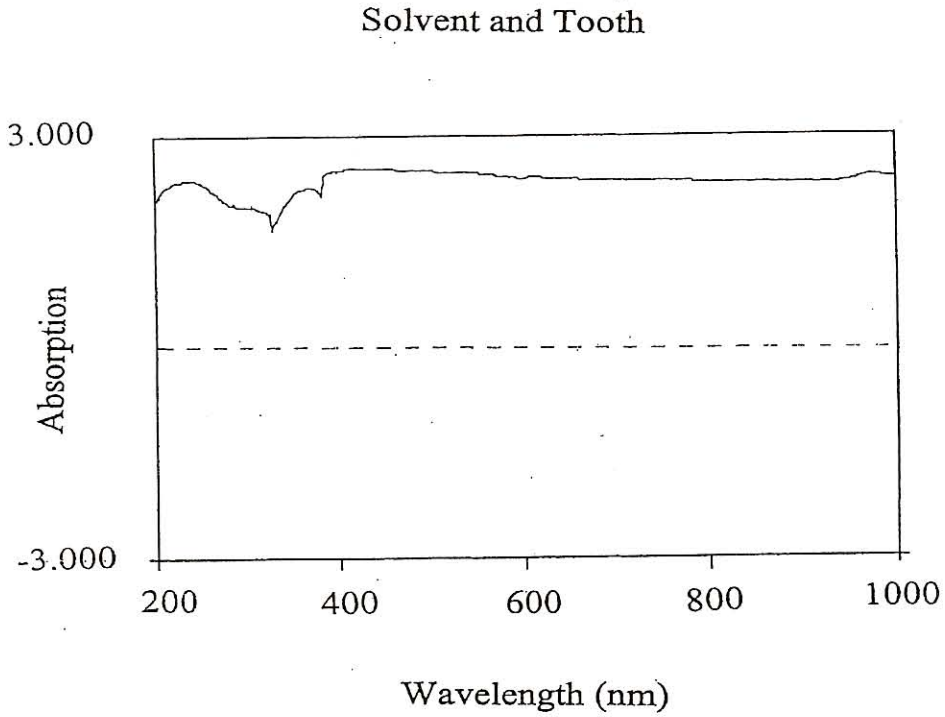

Fig. 3. The plot shows the absorption (and scattering) spectral features observed for the (solvent containing the Virgin tooth #6) sample in the 200 – 1000 nm region.

The present spectral data cover the wavelength range 200-1000 nm. In the future, we plan to take measurements on these samples in the mid-infrared region (400-4000 cm^{-1}), which will supplement the present data. It is anticipated that a comprehensive spectral database of these virgin and infected teeth samples from patients (in the age range 15-75 years) will aid in the development of a spectroscopic-clinical diagnostic protocol to detect and study the evolution and progression of dental decay.

Acknowledgment

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