Diffusion of Methylene Blue in Phantoms of Agar Using a Photoacoustic Technique

Lidia Vilca-Quispe [C, S], Pablo Martinez-Torres, Juan José Alvarado-Gil, Patricia Quintana, José May-Crespo and J. Ordonez-Miranda
CINVESTAV-IPN Unidad Mérida, Mérida, Yucatán, México

In this work the kinetics of diffusion of methylene blue in agar aqueous solution is studied using a photoacoustic technique. Agar phantoms are useful in medicine because it mimics any desired tissue, being simple and inexpensive to prepare [1]. One of the main aspects to understand the diffusion of substances in tissue, as happens for intramuscular medication when is administered. Agar phantoms in water with compositions of 0.1, 0.05 and 0.01 % vol. are analyzed. The study was performed using a modified Rosencwaig photoacoustic cell [2] that is closed on both sides by transparent windows. The sample is deposited directly on the window of the upper side. On the opposite side of the cell, the sample was illuminated with a modulated red laser beam. Each experiment was performed, measuring the photoacosutic signal at fixed frequency. At the beginning of the experiment 100μL of agar solution is deposited, when the signal stabilizes 10μL of methylene blue solution (0.0125 g/mL) is added to the surface of the agar with a micropipete. As a consequence, the amplitude and phase of the photoacoustic signal exhibit changes as a function of time. During the first seconds of the experiment, the amplitude of the signal increases followed by a gradual and long decay that could take hours until the signal stabilizes. The first stage registers the increase in the optical absorption coefficient due to the incorporation of methylene blue in a localized zone. The second stage has to do with the homogenization of the solute (methylene blue) inside of the agar. Results for modulation frequencies in the range from 10 to 80 Hz for different concentrations are presented, showing strong differences in the diffusion process. In order to understand the system, simulations of the evolution of the optical and thermal properties during the diffusion processes were performed.

[1] Ernest L Madsen, Maritza A Hobson, Hairong Shi, Tomy Varghese and Gary R Frank Phys. Med. Biol. 50 (2005) 5597–5618.
[2] Nils C. Fernelius, J. Appl. Phys.**51**(1), 1980.