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Modern optical sensor for liver state assessment in medical diagnostics

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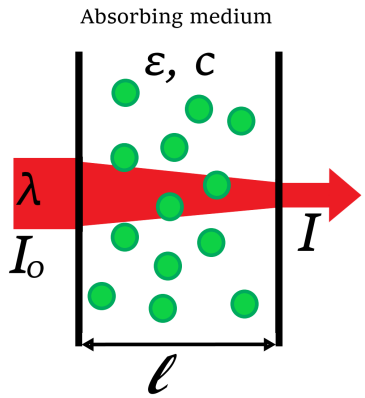


Optical densitometry is based on Bouguer-Beer-Lambert law.
Increase of the optical density of the medium decreases light transmission.

$$I = I_0 \cdot 10^{-\varepsilon \cdot c \cdot \ell}$$

Absorbance (optical density)

$$A = \varepsilon \cdot c \cdot \ell = -lg\left(\frac{I}{I_0}\right)$$

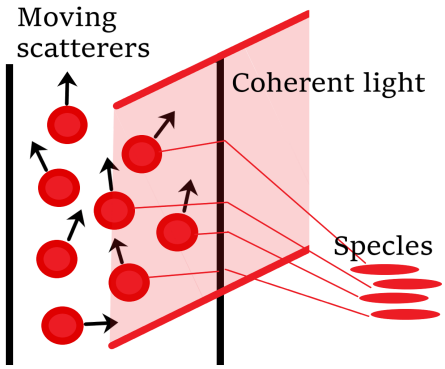
Absorptivity

$$\alpha = \varepsilon \cdot c = -\frac{1}{\ell} lg\left(\frac{I}{I_0}\right)$$

Liver metabolic function can be evaluated with diagnostical colorant concentration dynamics in patient's blood. Colorant extraction by the liver can be described as follows:

$$c = c_0 \cdot exp\left(-0.01 \cdot PDR \cdot t\right)$$

Where PDR is Plasma Dissappearance Rate, an important diagnostical parameter, which imply blood plasma clearance rate.



Normalized temporal autocorrelation function of speckle intensity fluctuations

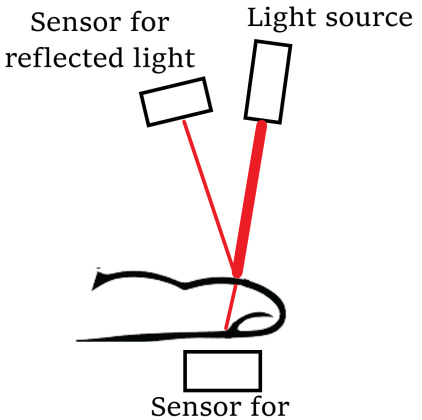
$$G_{\Delta I}(\tau) = e^{-\tau^2\left(\frac{\vartheta^2}{\omega^2} + \frac{(\omega\pi\sigma\theta)^2}{(\lambda l)^2}\right)}$$

Allows us to calculate the average speed of the scatterers

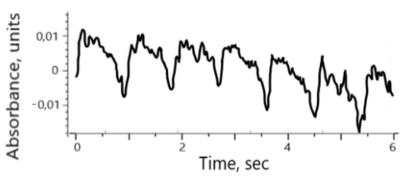
$$|\vartheta| = \frac{1}{\tau_c}\left(\frac{1}{\omega^2} + \frac{\sigma^2}{\Delta x^2}\right)^{-1/2}$$

Thus, dynamic light scattering can be used to measure the velosity of the erythrocytes moving in capillaries and to monitor the capillary blood flow.

Microcapillary blood flow measured in volunteers is within 1 - 5 mm/s.



This laboratory model of a combined optical sensor and the corresponding software allows non-invasive monitoring of the liver functional reserves



Fluctuating part of the absorbance graph corresponds to pulse wave.

Absorbance change during PDR measurement is around 0.1 units, while zero point shift of the finger absorbance can reach 0.02, which makes 20% error.

The use of a light source with several wavelengths makes it possible to measure the concentration of blood components that are not associated with a diagnostic dye and take into account their influence.