Photoacoustic lifetime imaging (PALI) of dissolved oxygen using Methylene Blue

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Abstract
Measuring distribution of dissolved oxygen in biological tissue is of prime interest for cancer diagnosis, prognosis and therapy optimization. Tumor hypoxia indicates poor prognosis and resistance to radiotherapy. Despite its major clinical significance, no current imaging modality provides direct imaging of tissue oxygen. We propose a new technique for oxygen imaging in tissue by using photoacoustic lifetime imaging (PALI). The technique is based on photoacoustic probing of excited state lifetime of Methylene Blue (MB) dye. MB is an FDA approved, water soluble dye, with a peak absorption at 660 nm.

A double pulse laser system (pump-probe) is used to excite the dye and probe its transient absorption by detecting photoacoustic emission. The relaxation rate of MB in its excited state depends linearly on oxygen concentration. Our measurements show high photoacoustic signal contrast at a probe wavelength of 810 nm where the excited state absorption is more than 4 times higher than the ground state absorption. Imaging of a simple phantom is demonstrated in Figure 1.

To conclude we will discuss the possible implementations of the technique in clinical settings and combining it with Photodynamic Therapy (PDT) for real time therapy monitoring.