Wavelength agile photoacoustic microscopy with a pulsed supercontinuum source

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Photoacoustic microscopy (PAM) provides excellent image contrast based on optical absorption [1,2]. Spectroscopic imaging requires a wavelength tunable pulsed nanosecond laser, which can be expensive and difficult to rapidly switch between wavelengths. We are developing a multiwavelength photoacoustic microscopy system based on a pulsed optical source with high repetition rate (i.e. several kHz) and rapid wavelength tunability [3].

The key feature is the generation of an ultrabroadband spectrum by propagating sub-nanosecond pulses from a Q-switched microchip laser through several meters of photonic crystal fiber (PCF) [4]. The supercontinuum is sent through a prism-based monochromator that can rapidly select the desired wavelength. The selected wavelength is sent to a photoacoustic microscopy system, where seven different wavelengths (575 to 875 nm) are acquired in less than one second for each image pixel.

Multiwavelength imaging is tested on an optically scattering phantom containing cotton threads stained with different color dyes. The figure below shows the photoacoustic images at 575 and 675 nm. All images are shown over a 600 x 600 µm region. Multiwavelength processing correctly identifies the color of each fiber. A major advantage of our tunable source is the rapid access to widely separated wavelengths. We believe this tunable laser can significantly benefit spectroscopic applications of optical resolution photoacoustic microscopy.

Fig. 1: (a) Rapidly tunable filter to select the desired wavelength from the pulsed supercontinuum. Maximum amplitude project (MAP) images taken at (b) $\lambda = 575$ nm and (c) $\lambda = 675$ nm. The scale bar represents 150 µm. (d) Images taken at seven different wavelengths are processed to form the color coded image.

References