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Supercontinuum based mid-infrared OCT, spectroscopy, and hyperspectral imaging

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Mid-infrared (MIR) spatially coherent supercontinuum (SC) fiber lasers with high brightness and average power find important applications in spectroscopy-based trace gas detection, such as in pollution and food-quality monitoring. Early commercial MIR SC lasers have been limited to about 4.5µm, mainly by the transmission bandwidth of the fluoride fibers typically used for the SC generation. Research-based MIR SC lasers have reached 15µm, but with very low power and/or bulky and expensive pump lasers, making them irrelevant for applications. Recently the use of SC cascading in a combination of fluoride and chalcogenide fibers have seen MIR SC lasers reaching 11µm with average powers around 100mW and high repetition rates [1,2]. Here we review the state-of-the art in MIR SC lasers and demonstrate a design that provides MHz repetition rates while not using any amplifier along the fiber chain, which makes it simple, cheap and robust [2] [see spectrum in Fig. 1(g)]. Such MHz MIR SC lasers covering most of the molecular fingerprint region are ideal for hyperspectral imaging [3] [see Fig. 1(a-f)] and real-time Optical Coherence tomography (OCT) when combined with ultra-fast upconversion detectors [4] [see Fig. 1(h-k)]. We present the latest results within these two particular applications, as well as in spectroscopy based trace-gas detection.

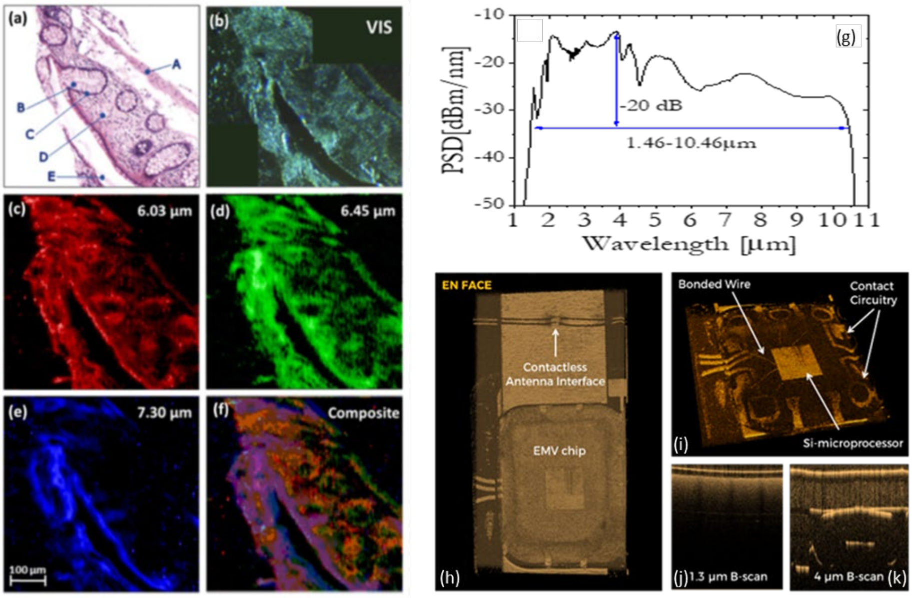

Fig. 1 (a) Confocal image of stained colon tissue with marked histological regions. (b) Visible light transmission image of the un-stained sample. MIR absorbance images of (c-d) the protein rich amide regions highlighting the nuclear regions of the colonic crypts and (e) the mucin secretions and surface epithelial walls. (f) Composite image showing the spectral-spatial mapping of (c-e). (g) MIR SC spectrum. 4µm MIR OCT volume scan of an EMV chip and NFC antenna embedded in a credit card. (h) En-face image. (i) Zoom-in on the EMV chip. (j-k) Comparison between B-scans obtained using a 1.3µm OCT system that cannot penetrate (j) and a 4µm MIR OCT system (k).

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