Multispectral mid-infrared imaging using frequency upconversion

It has recently been shown that it is possible to upconvert infrared images to the near infrared region with high quantum efficiency and low noise by three-wave mixing with a laser field [1]. If the mixing laser is single-frequency, the upconverted image is simply a band-pass filtered version of the infrared object field, with a bandwidth corresponding given by the acceptance parameter of the conversion process, and a center frequency given by the phase-match condition. Tuning of the phase-matched wavelengths has previously been demonstrated by changing the temperature [2] or angle [3] of the nonlinear material. Unfortunately, temperature tuning is slow, and angle tuning typically results in alignment issues. Here we present a novel approach where the wavelength of the mixing field is used as a tuning parameter, allowing for fast tuning and hence potentially fast image acquisition, paving the way for upconversion based real time multispectral imaging. In the present realization the upconversion module consists of an external cavity tapered diode laser in a Littrow configuration with a computer controlled feedback grating. The output from a tunable laser is used as seed for a fiber amplifier system, boosting the power to approx. 3 W over the tuning range from 1025 to 1085 nm. Using a periodically poled lithium niobate crystal, the infrared wavelength that can be phase-matched is tunable over more than 200 nm. Using a crystal with multiple poling periods allows for upconversion within the entire transparency range of the nonlinear material.

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