RAPID MID-IR IMAGING USING LASER-BASED FTIR SPECTROSCOPY AT 10 µm SPATIAL RESOLUTION

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We present a novel light source for FTIR spectroscopy that enables rapid and low noise detection of minute amounts of molecules in the molecular fingerprint region. Due to its simplicity, compactness and performance this concept offers a variety of novel applications in MIR spectroscopy and life sciences. To demonstrate the ability of laser-based FTIR spectroscopy, we mapped a 65x65 µm area of C_{60} and pentacene molecules at 7 µm wavelength. We give an outlook on the successful detection of poly-L-lysine proteins on a single gold nano-antenna.
Compared to common FTIR light sources such as Globars or synchrotrons, lasers offer a several orders of magnitude higher brilliance. This enables measurements using very small apertures at a significantly increased signal-to-noise ratio (SNR) [1]. Our light source is based on a solid-state laser and a fiber-feedback optical parametric oscillator [2]. The system exhibits very low noise and excellent wavelength and power stability over several hours, which is essential in spectroscopy. By means of difference frequency generation mid-IR radiation between 4 – 8 µm at a $1/e^2$ bandwidth of 446 nm (93 cm^{-1}) is generated. Using a more powerful pump laser, the wavelength can be tuned from 1.33 to 20 µm [2]. Figure 1 depicts an FTIR image at 7 µm (1428 cm^{-1}), revealing clear chemical contrast between 100 nm thick layers of C_{60} and pentacene. The map is measured with an aperture size of 10x10 µm, which is close to the diffraction limit. A relative sensitivity below 1% is achieved by averaging 30 spectra per pixel. Thus, 4 minutes measurement time per pixel is required.

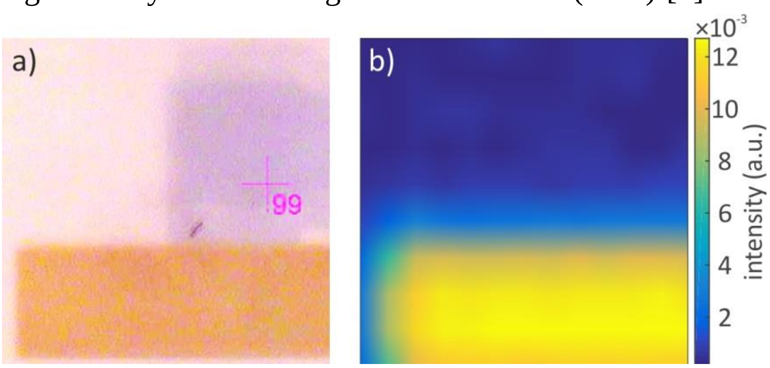

Fig. 1: a) Sample image (65x65 µm) containing C_{60} and pentacene (marker). b) MIR image of the C_{60} layer, measured at 7 µm wavelength, exhibiting a high SNR.

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