Infrared Microscopy with Visible Light

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The mid-infrared (mid-IR) "fingerprint" range is of big interest to scientists, since it contains a number of absorption bands of materials and gases. However, classical infrared spectroscopy methods have disadvantages: low quantum efficiency of semiconductor detectors; high shot and thermal noise, as a result – low signal-to-noise ratio; as well as a narrow spectral tuning range of the devices themselves.

A novel promising method for probing and studying the properties of gases in the mid-IR range can be nonlinear interferometry [1,2], which address the disadvantages mentioned above. Nonlinear interferometry exploits the correlations of photon pairs (signal and idler) generated via spontaneous parametric down conversion in a nonlinear crystal. Due to correlations interference of signal SPDC photos depends amplitude on and phases of idler photons as well. In our work, we demonstrate the application of the method using a common-path nonlinear interferometer with lithium niobate nonlinear crystal [3]. Continuous wave laser with 532 nm wavelengths allows to generate frequency nondegenerate spontaneous parametric down conversion photons pairs at 580-615 nm and 4-6 µm for signal and idler modes, respectively. We use a mixture of N_2O and CO_2 gases as a sample, which have characteristic absorption lines at 4.5 and 4.27 µm, respectively. As a result, by recording the frequency-angular spectrum of signal SPDC photons at visible range, we detect the presence and concentration of the gas at IR range of wavelengths.

References

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