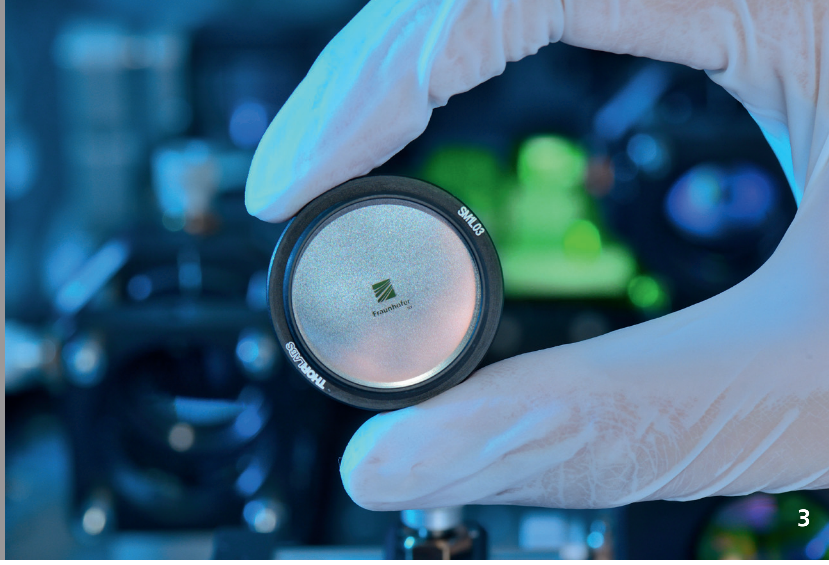

HIGH-RESOLUTION QUANTUM IMAGING IN MIR WITH NON-DETECTED PHOTONS

Task

Quantum imaging uses non-classical photon states to overcome the limitations of classical imaging. For example, wavelength-shifted entangled photon pairs can be used to separate the measurement and detection wavelengths in imaging processes and to independently optimize them for the particular measurement required. Samples scanned in difficult-to-access but highly interesting spectral regions such as the mid-infrared can be investigated, while image information is generated in the easily detectable visible spectral range of light. One process to achieve this is "non-detected photon imaging", where the photons interacting with the sample do not need to be detected and images are acquired interferometrically using only the entangled partner photons.

Method

Fraunhofer ILT has developed photon sources and quantum interferometers within the Fraunhofer QUILT lighthouse project, which allow high-resolution imaging analyses in the mid-infrared. Here, measurement wavelengths in the range from 1.5 to greater than 4.5 µm could be demonstrated, with the detection wavelength lying in the range around 600–700 nm. With this wavelength, both photons can be detected efficiently and with low noise using low-cost and sophisticated silicon-based cameras. A large-aperture lithium niobate crystal pumped at 532 nm is used to generate the photon pairs. By building the interferometer in a special long-pass configuration with broadband-coated optics, the institute can probe the entire wavelength range of the sources with a single setup.

Results

Non-polarized, large aperture crystals can be used to acquire very detailed images in the mid-infrared compared to the state of the art. The number of resolvable pixels is about 12,000 at a resolvable structure size of 70 µm and an image field diameter of more than 7 mm, which is an order of magnitude higher than previous results in this wavelength range. The institute is continuing to improve the process.

Applications

The developed setup forms the basis for investigating novel applications of quantum imaging in the life sciences and materials testing. The lower cost of the image sensor and the operation at room temperature may make it applicable in a wide range of commercial settings.

The work was funded by the Fraunhofer-Gesellschaft as part of the QUILT lighthouse project.

Contact

Florian Elsen M. Sc., Ext: -224
florian.elsen@ilt.fraunhofer.de

Dr. Bernd Jungbluth, Ext: -414
bernd.jungbluth@ilt.fraunhofer.de

2 Image of the test object with measuring wavelength 3.4 µm.

3 Transmission object for the quantum interferometer.