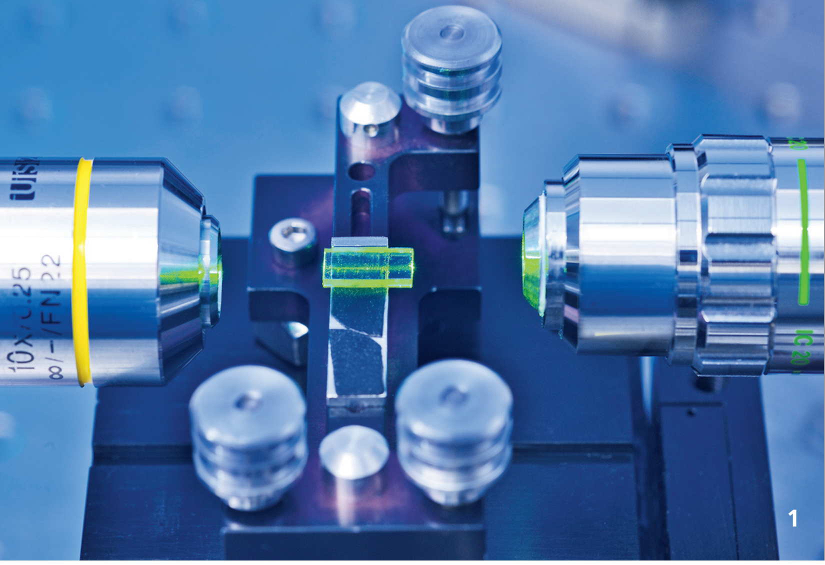

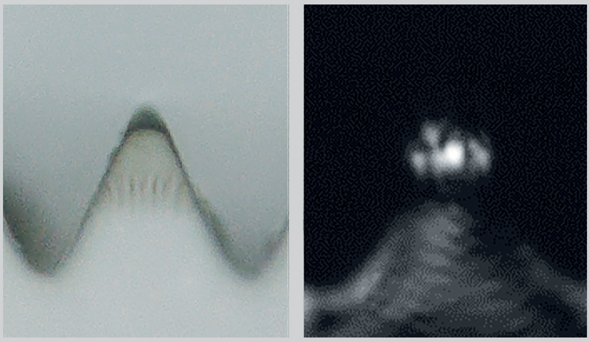

WAVEGUIDES IN LITHIUM NIOBATE FOR QUANTUM TECHNOLOGY

Task

In the context of the second quantum revolution, novel technologies have been developed by selectively exploiting fundamental quantum effects, and first application examples demonstrated on a laboratory scale. In order to ensure that the developed technologies can be transferred to a broad range of applications, the industry needs new fabrication methods and manufacturing concepts to miniaturize and integrate quantum system components on chip level. Core components are optical waveguides in non-linear media such as lithium niobate, which enable different assemblies to be interconnected optically. Microstructuring using ultrashort pulsed laser radiation makes it possible to directly produce high-quality waveguides with high geometrical freedom and productivity.

Method

A two-stage process using ultrashort pulsed laser radiation is used to fabricate the waveguides in periodically poled lithium niobate. First, the starting material is modified with infrared laser radiation a few micrometers below the surface so that a boundary surface with reduced refractive index is created there. Subsequently, the surface is ablated to create the geometric outer contour of the ribbed waveguide using ultraviolet laser radiation.

1 Free beam coupling into the waveguide.

2 Light microscopy and mode guiding of a waveguide.

Results

Fraunhofer ILT determined which process and geometry parameters were relevant to manufacture the waveguides. The interface structuring with a height of about 15 µm spatially limits the guidance of the mode field to a small area of the waveguide. The geometrical requirements for widths and heights of 5 to 50 µm each and a sidewall angle of 60° were developed. The institute could fabricate complex waveguide networks by suitably developing the laser scanning strategy. Compared to lithographic methods, laser structuring is significantly more productive.

Applications

Waveguides in periodically poled lithium niobate enable efficient optical frequency conversion and can be integrated at a chip level. They can therefore be applied, for example, in optical networking technologies for wavelength division multiplexing (WDM) or in the life sciences for photonically integrated chips (PIC). The waveguides can also be used to generate entangled photons – a promising approach for applications such as quantum spectroscopy or quantum imaging.

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