Scientific Highlight

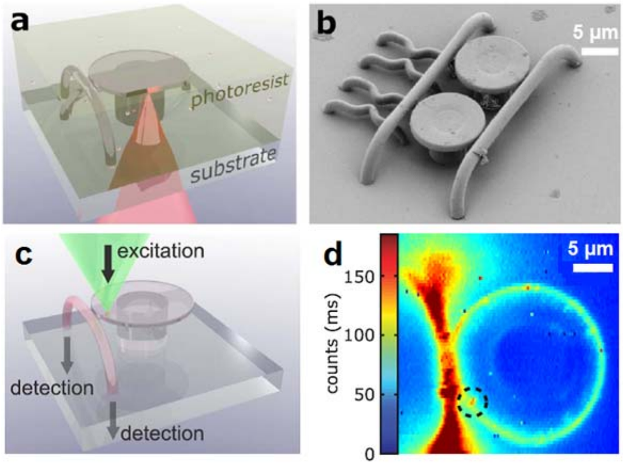
Quantum Light from Diamond and Plastic

A group of researchers led by IRIS Adlershof member Oliver Benson has developed a simple method to fabricate stable sources of single light quanta. The approach published in the Open Access Journal Scientific Reports of Nature Publishing Group is based on a novel hybrid approach combining two completely different material systems.

On the one side, there are tiny fragments of diamond. Besides carbon diamond contains other atoms as natural impurities. These impurity atoms or so-called colour centres are responsible for the yellow or blue colours of natural diamond. Due to their very small size of only a few millionths of a millimetre, some of the diamond fragments contained only a single colour centre, which could be excited optically with the help of laser light. The colour centre releases its energy by emission of single quanta of light, or photons, which are thus generated in a controlled way one-by-one. The researchers now mixed the diamond fragments with a special photo resist.

A focussed laser beam irradiating the resist layer induced local polymerisation, i.e. the resist was turned into plastic. In this way it was possible to write nearly arbitrary three-dimensional structures, which contain single diamond fragments with single colour centres. The research team at first fabricated optical waveguides and resonators for efficient collection and routing of the photons emitted from the colour centres.

A major advantage of the new hybrid material system is on the one hand the well-established and cost efficient fabrication method and on the other hand the unlimited stability of operation even at room temperature. The next steps are now to combine the novel structures with other optical instrumentation. The researchers expect that in this way numerous applications in the fields of high-resolution microscopy, optical sensing, or quantum information processing can be realized in a reliable and cost-efficient approach.



Figures:
(a) Fabrication principle of optical disc resonators and bent waveguides using local polymerisation of a photoresist through a focussed laser beam.
(b) Scanning electron microscopy image of a test structure.
(c) Schematic of the generation and measurement of quantum light. A diamond fragment containing a single colour centre is excited optically by a laser. The emitted photons are collected by the resonator and coupled to the waveguide. Detection is performed at the two ends of the waveguide.
(d) Scanning fluorescence microscopy image of the structure shown in (c). A circle indicates the fluorescing diamond fragment.

Three-dimensional quantum photonic elements based on single nitrogen vacancy-centres in laser-written microstructures

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