Fiber-Pigtail with Photon Source

SNI team develops robust, easy-to-operate source of quantum light

In the last couple of years, Argovia professor Martino Poggio has been studying nanowires, especially their application as multifunctional sensors. Nanowires only have a diameter of a few nanometers. They either self-assemble from molecular components or are produced from larger structures by micro fabrication techniques. Because of their small dimensions and their large length-to-width ratio, nanowires possess special electronic, optical, and mechanical properties. In a recently published paper in Applied Physics Letters[1], the Poggio team together with colleagues from Basel and Grenoble describe how they developed a robust source for quantum light using specific nanowires. The researchers attach a tapered nanowire that contains quantum dots at its tip to the center of a single optical fiber. The quantum dots emit single photons without functionalization or an external electric field. This tiny "quantum fiber pigtail" can easily be integrated into an optical system and, for example, be used as a sensor.

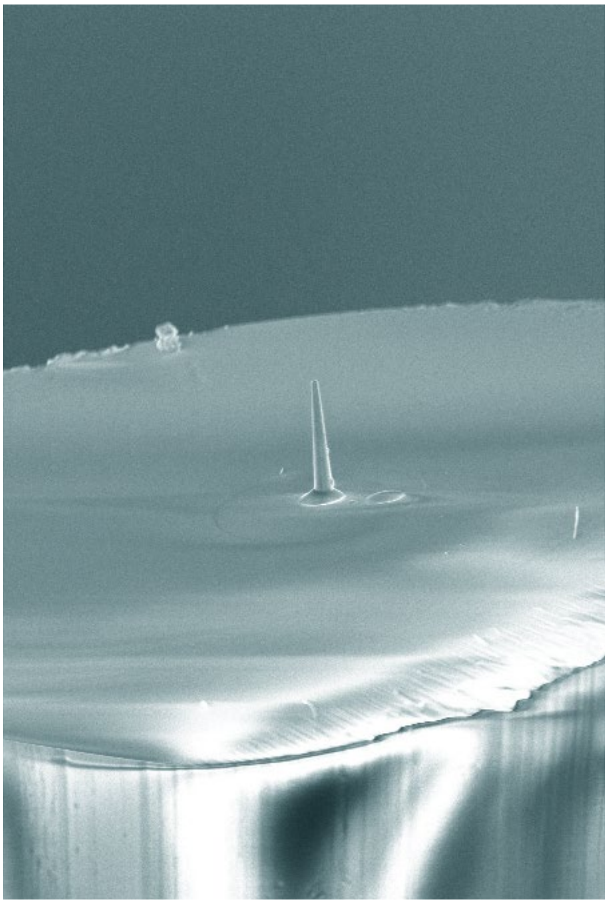
Ubiquitous optical fibers

Today, optical fibers are widely used. The thin flexible, transparent fibers are made from finely pulled glass and are frequently used as a means to transmit information. Fiber-optic links have largely replaced copper wire in core communications links as signals travelling along optical fiber suffer fewer losses than wire cables and are immune to electromagnetic interference. Typically, optical fibers are bundled to multi-fiber cables and are terminated with connectors, so that they can be easily attached to other equipment. Short lengths of fiber with a connector on one end and an exposed fiber on the other end are known in the industry as "fiber pigtails" and are generally used for making connections to individual fibers of a multi-fiber cable or for direct connections to photo-receivers or other optical devices.

1 APPLIED PHYSICS LETTERS 108, 011112 (2016)

Source for quantum light

Researchers in the labs of Argovia professor Martino Poggio and professor Richard Warburton from the Department of Physics in Basel have recently developed a so-called “quantum fiber pigtail” that is a source for quantum light which makes it promising for applications in quantum communication and in precision sensing. The fiber pigtail has semiconductor quantum dots attached to one end, which provide on-demand single photons. Unlike conventional sources for quantum light, which are often complex networks of bulky free-space optical components, the “quantum fiber pigtail” is robust, compact and easy-to-operate and promises to bring single photon sources to any user able to work with optical fiber.



Combination of quantum dots and nanowire

In order to realize the “quantum fiber pigtail”, the Basel researchers, led by SNI-PhD student Davide Cadeddu and post-docs Mathieu Munsch and Jean Teissier, used a short tapered nanowire. They embedded quantum dots, which are efficient single photon emitters, at the tip of the wire. Colleagues from Grenoble produced these specific wires, which are called “photonic trumpets” due to their appearance.

Then, the scientists directly attached the trumpet to the cleaved end of a single mode fiber with a connector on the other end. Because of the tiny dimensions of the objects, the team carried out this attachment process with a hydraulically actuated micro-manipulator under a high-power optical microscope. “The connection between trumpet and fiber is remarkably robust and can be achieved within a couple of hours”, explains Martino Poggio the work of his co-workers, who show the entire process on YouTube (https://youtu.be/E_A3y_K3kRw).

Application to other quantum systems

“The results demonstrate that it is possible to develop an easy-to-operate single photon source, which is straightforward to integrate and has potential applications in quantum optics or metrology”, adds Poggio. “Our approach provides a solution for maximizing light extraction from quantum dots, however, it is generic and could be applied to other quantum systems, including in emitters in diamond or silicon.” Furthermore, easily addressable quantum dots or other emitters at the end of a nanometer-scale tip have obvious potential as scanning probes.