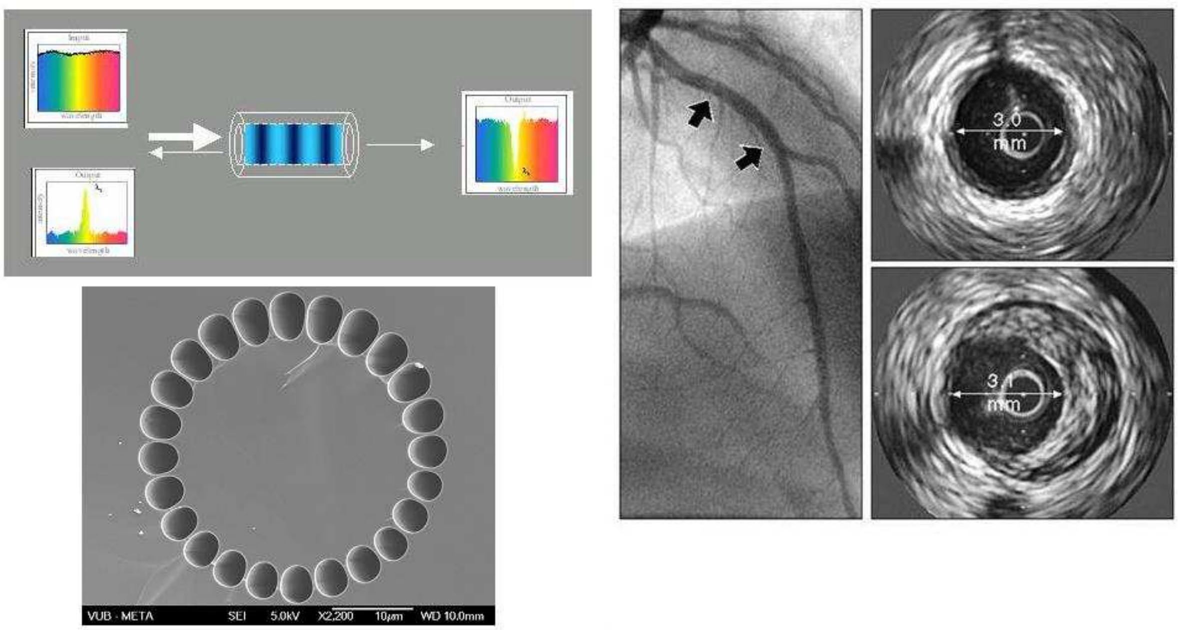
Vrije Universiteit Brussel

Faculty of Engineering (FirW)
Departement of Applied Physics and Photonics (TONA)

photonics 4 life

Biophotonics '09 Application form

Fiber optic micro-structured sensors for biomedical applications



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Abstract (≤ 500 words)

The introduction of minimally invasive interventions (MII) into the surgical world is one of the medical revolutions of the 20th century. The evolution from conventional 'open' surgeries to MII (or 'keyhole' operations) is a result from the notion that minimizing the trauma to tissue and adjacent organs during the intervention is as important as achieving a satisfying therapeutic result, even if this means that the procedure becomes technically more challenging. The key difference lies in the incision(s): MII use small incisions of several millimeters (instead of centimeters for conventional operations) through which the sophisticated medical tools are inserted.

One of the key tools for MII is the endoscope, which is either a fiber optic bundle or a combination of GRIN lenses. Although the modern endoscope is far more advanced than its early predecessors, it still possesses limitations which restrict its possible applications in MII. Some of the most prominent limitations of the current endocopes are: a Field Of View (FOV) limited by its trade-off with resolution, an outer diameter which is still too large to access some parts in the body, lack of shape sensing of the sensor while inserted in the body. The aim of my PhD, which started in September 2008, is to design a new fiber optic sensor which would be able to overcome these limitations and thus expand the possible biomedical functionalities of fiber optics sensors. To achieve this I am investigating two designs, based on different types of fiber optic sensor, each aimed at overcoming one of the limitations (either the field of view or the shape sensing) while having an outer diameter of 150 microns or less. The concept for the first sensor is based on a microstructured, multicore optical fiber. Instead of using opto-mechanics to enlarge the FOV, the scanning of the light at the distal end of the sensor would be realized by a combination of wavefront shaping and adaptive optics. If the phase profile of the microstructured fiber is known, in other words if the way it deforms a plane wavefront during propagation is known, than by shaping the wavefront before the light is coupled in the sensor, the direction with which the light exits the sensor could be controlled.

The concept for the second sensor is based on a multicore fiber where each core is a single mode fiber with integrated Fiber Bragg Gratings. Recently, results have been publicized validating this concept for 3D shape sensing in industrial applications (e.g. aeronautics). Concerning this concept I will investigate if this is applicable to sensors for MII. Thus, there are two challenges that I will take on during my research which are the miniaturization to an outer diameter of less than 150 microns and the accuracy of the sensor for very small radii of curvature.

Using the experience gained through the research and development of the two previously described sensors, I will try to design a fiber optic sensor with an outer diameter of less than 150 microns, which combines a wide FOV and has a 3D shape sensing capability.