Photonic Sensors in Ophthalmological Sutures (PHAETHON)

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ABSTRACT

A common complication in cornea transplantation is transplant astigmatic distortion, which occurs when uneven strain is applied to the sutures during stitching [1]. This distortion can significantly impair the patient's vision, often necessitating additional corrective procedures that carry further risks and substantially increase medical costs. The research project Photonic Sensors in Ophthalmological Sutures (PHAETHON) aims to demonstrate, for the first time, a new type of "smart sutures" that utilize photonic and optical fiber sensing technologies [2]. These innovative sutures will enable surgeons to monitor the strain applied to the sutures in real time during surgery and adjust the tension accordingly throughout the cornea stitching process.

For the development of the sensor, a standard polypropylene (PP) ophthalmological suture of 150 μm diameter was connected to a multimode silica optical fiber through a customized connector, allowing simultaneously suture handling and light coupling (Fig 1a). Experiments verified that losses in the 1520-1615nm range are below 2dB/cm allowing operation of the sensor at the eye-safe optical telecommunications window. Bragg reflectors were inscribed in the suture using 248-nm KrF excimer laser radiation [2] and were characterized for their response to strain, and temperature. Temperature and strain sensitivities were measured to be -145 pm/℃ and 1.62 pm/με correspondingly (Fig 1b and 1c).

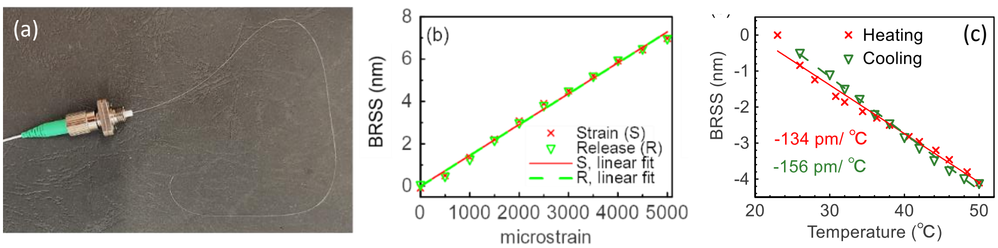

Figure 1. (a) Photograph of the suture connected with a silica fiber using an FC connector, (b) Bragg reflector spectral shift (BRSS) versus applied suture strain up to 5000 με, and (c) BRSS versus suture temperature.

The technologies developed within PHAETHON project have successfully reached laboratory demonstration prototypes (TRL4), while pre-clinical tests have been planned for the immediate future. PHAETHON has been funded by the European Union NextGenerationEU under the call RESEARCH – CREATE – INNOVATE 16971 Recovery and Resilience Facility (TAEDK-06170).

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