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TecInTex RTD 2009

FNSNF

Biosensing with Optical Fiber Fabrics

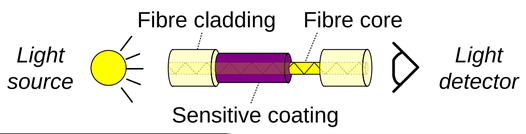
B. Schyrr[1,2], S. Pasche[1], R. Ischer[1], D. Ferrario[1], J.-A. Porchet[1], G. Voirin[1]
M. Krehel[3], R.M. Rossi[3], L.J. Scherer[3]

[1]CSEM Centre Suisse d'Electronique et de Microtechnique SA, Neuchâtel, Switzerland
[2]Adolphe Merkle Institute, University of Fribourg, Switzerland
[3]Laboratory for Protection and Physiology, EMPA St. Gallen, Switzerland

The TecInTex project aims at the development of truly wearable functional clothes. In this context, biosensors based on optical fibers are designed for the continuous monitoring of biological parameters in wounds. Glass and polymer optical fibers have been modified by coating the core with a sensitive layer, which allows optical detection of pH in liquid. In parallel, optical fibers are being developed for monitoring the activity of proteases. Combination of the sensing fibers with portable electronics and integration into a textile prototype will result in a wearable sensor performing real-time measurement in close contact to the body. In addition, embroidery of highly flexible polymer optical fibers is being exploited for measuring perfusion with a textile. Signal acquisition and processing are being developed in parallel for both approaches.

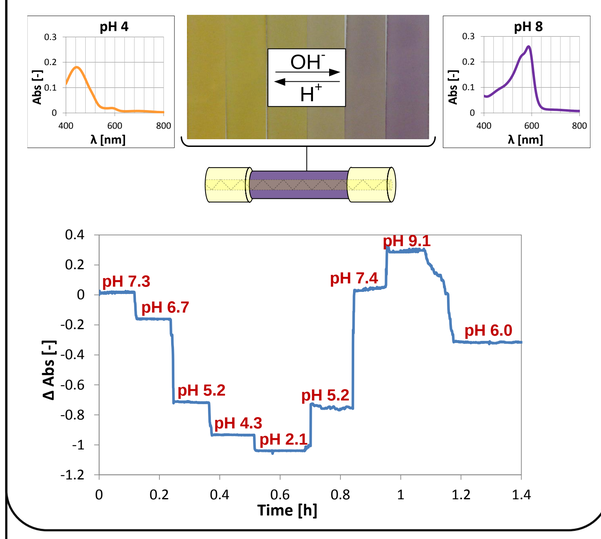
Optical Fibers for Biosensing

Detection relies on light transmission variation when a sensitive coating deposited on the core of the optical fiber is exposed to different environments.



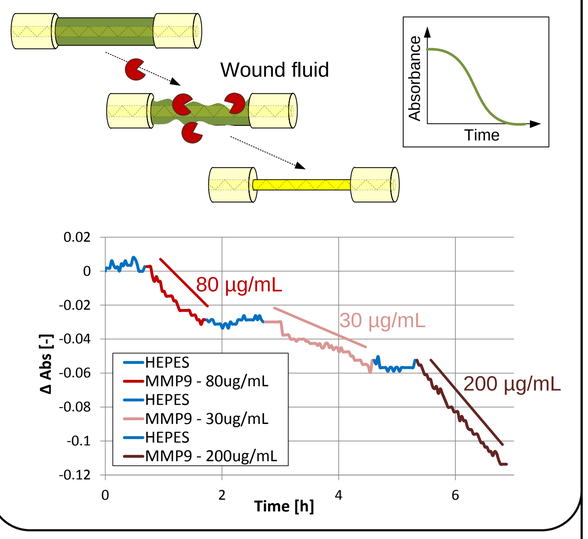
pH sensing

pH indicators are encapsulated inside a porous sol-gel coating. pH variations induce a change in color of the sensing layer.

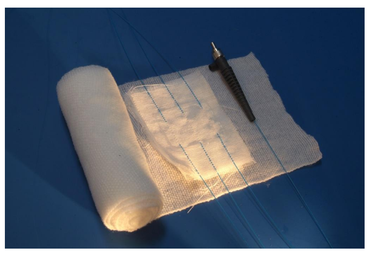


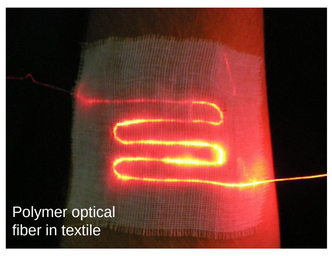
Protease (MMP-9) activity detection

The sensing layer consists in a stained degradable polymer film. Digestion of the coating by the enzyme decreases the fraction of absorbed light.



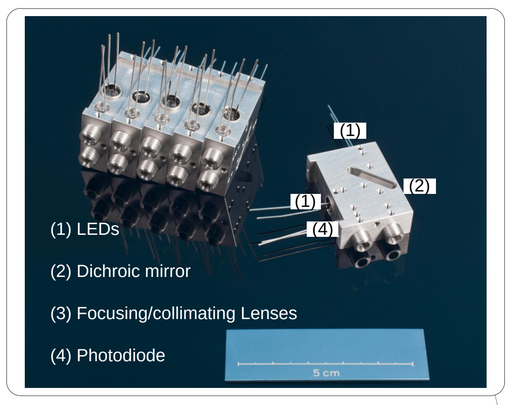
Biosensing optical fibers are developed for monitoring wound healing in real time.

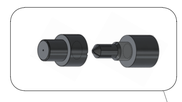


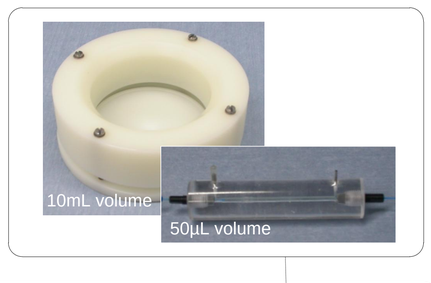


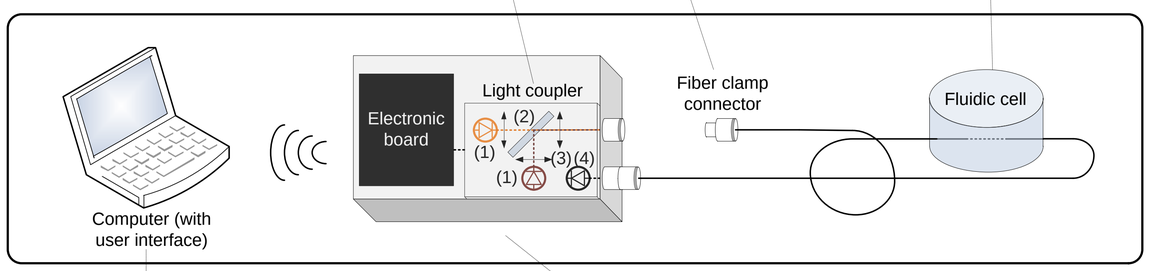
Development of Prototypes

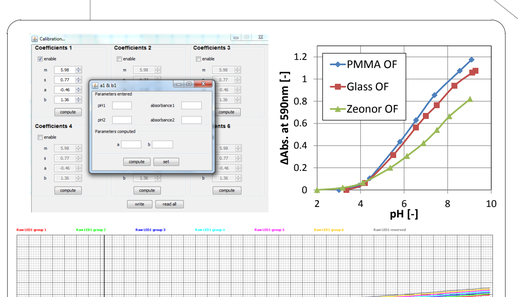
An experimental setup allows test measurements and calibration of sensing optical fibers.

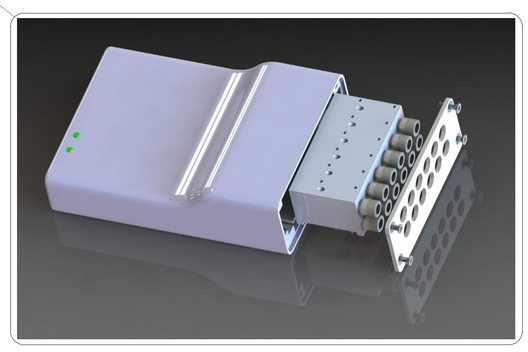




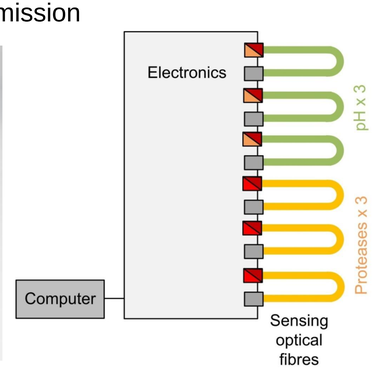






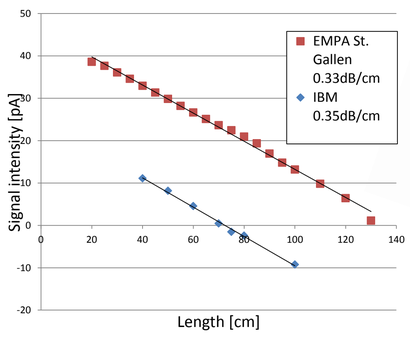


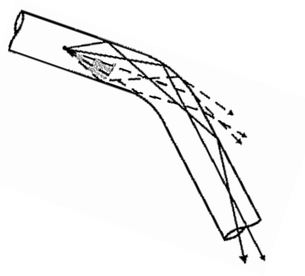
- **Integration** of opto-electronic components with modular optics
- **Multiplexing** (6 biosensing fiber in parrallel: 3 for pH sensing and 3 for protease detection) and temperature sensor
- DataLogger for **recording** and **real-time** transmission



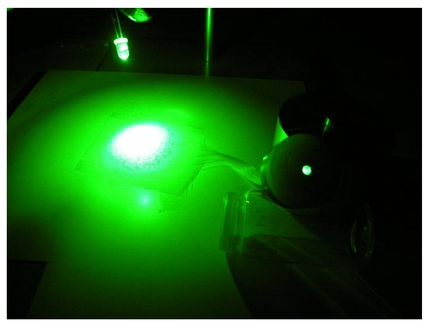
Perfusion Measurement with POF

The fibers that will be used are produced at EMPA St. Gallen and have enhanced flexibility and mechanical strength and are therefore ideally suited for embroideries. When the fiber is bent the critical angle can be exceeded and the light will be out/in coupled from/to the optical fibers.

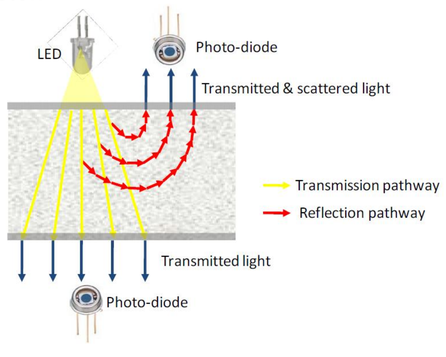


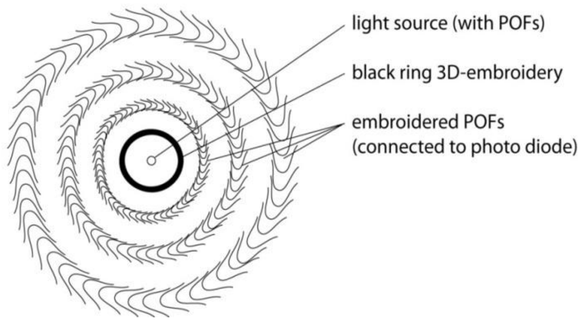


Mark G. Kuzyk, Polymer Fiber Optics, Fig 4.5 (a), p. 102



Perfusion measurement for wound healing monitoring relies on the difference in light absorption in the tissue. Measuring the light at different distances can deliver information about the tissue at different depths. Stitched flexible Polymeric Optics Fibers (fPOFs) can act as light source and detector.

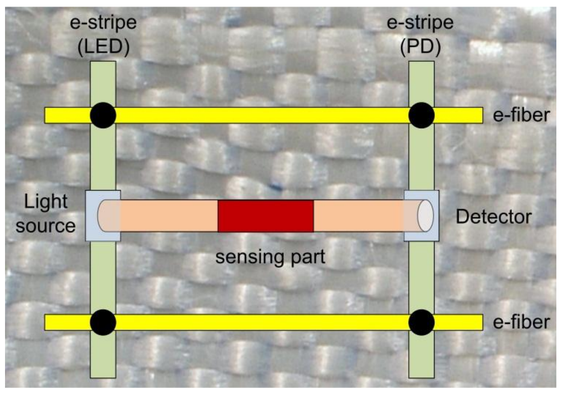




Next Steps & Outlook

Optical fibers for sensing

- Tests of pH and protease sensing fibers in real conditions (on body)
- Development and implementation of a new sensing layer for protease activity



Integration

- e-to-o transducer for textile integration
- Prototype for 6 biosensing fibers in parallel
- Prototype for perfusion measurement

On body tests

- pH measurement on skin (in sweat)
- Perfusion measurement on body