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TecInTex RTD 2009

FNSNF

Optoelectronic integration in textile for wearable sensors

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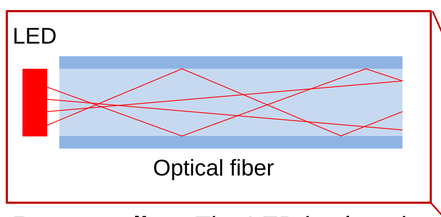
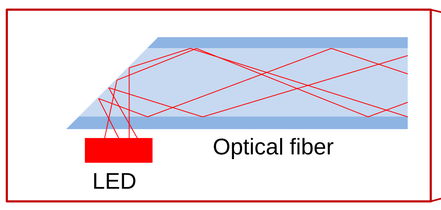
Different configurations have been used for optical fibers integration in textile. Generally, the connection with the light source was made outside the textile but in order to demonstrate the complete integration possibilities, configurations compatible with electronic ribbons were designed and realized. Promising configurations using fiber end faces at 45° or special fibers with fluorescent core/cladding are presented. Sensor integrations using different optoelectronic configurations are also presented.

Coupling light in/out optical fibers

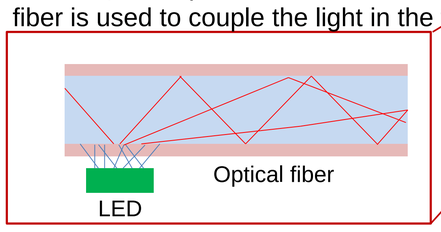
Configurations



Butt coupling: The LED is placed in front of the fiber core

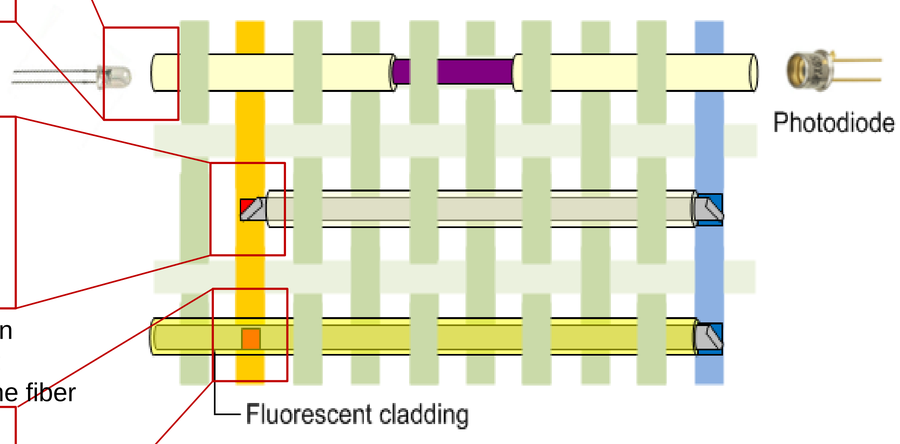


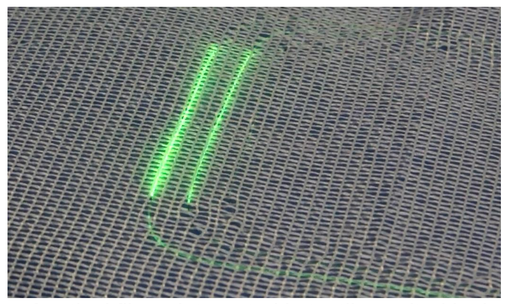
Mirror at 45°: The fiber is placed on the LED, a 45° prism or the 45° cut fiber is used to couple the light in the fiber



Fluorescent fiber core or cladding: The fiber is placed on the LED that excite the florescent cladding or core. The fluorescent light is guided in the fiber

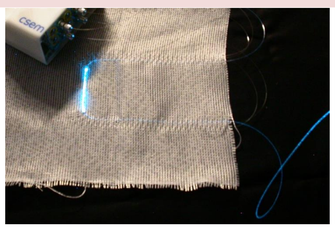
Integration in textile

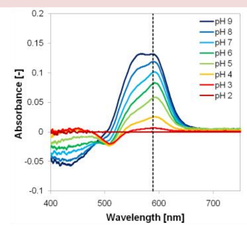




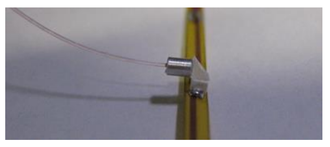
View of optical fibers integrated in textile excited by butt coupling of a laser. The more visible part is the part where the cladding was modified to become sensitive

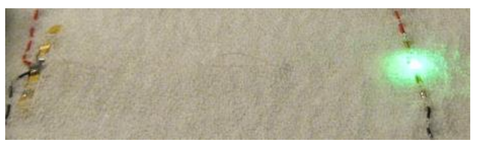
Realisations



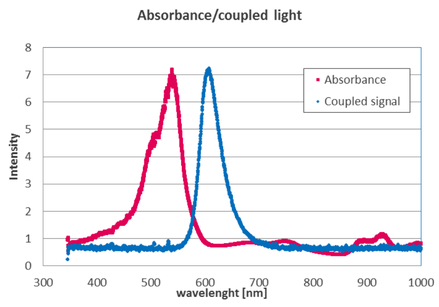


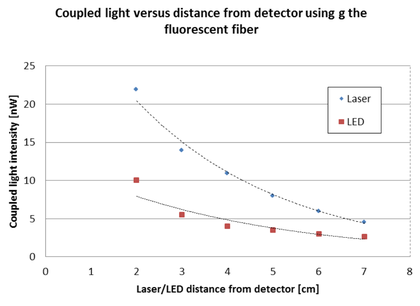
Butt coupling: This method was used to coupled LED light from the portable electronic to the optical fibers and to perform the caractarization of the optical fibers. The connection is dismountable and need a simple connector





Mirror at 45°: This configuration is compatible with LED placed in electronic ribbon. It is a simple way to combine electronics and fibers in textiles. A prism or a specially cut fiber is needed

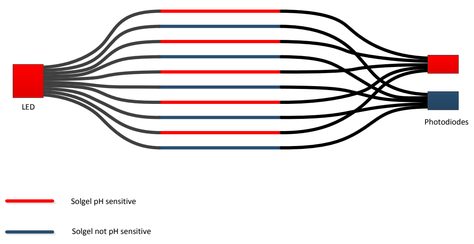




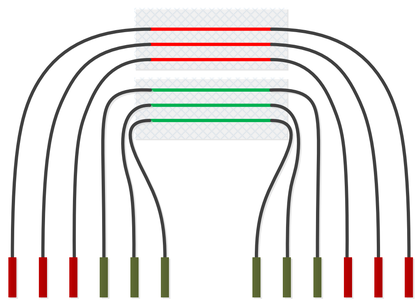
Fluorescent fiber core or cladding: Using special fibers fabricated by EMPA, it is possible to excite light in the fiber using an external light source illuminating the special fiber. This can be also integrated with electronics on ribbons and fully integrated in textile. To be efficient it will be necessary to only modify the coupling portion of the fiber

Sensor integrations

Configurations

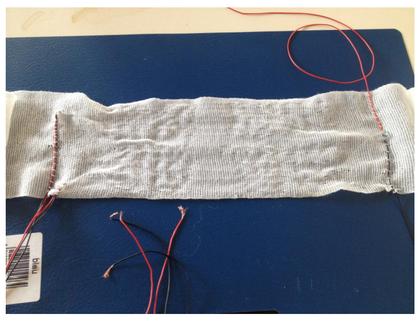


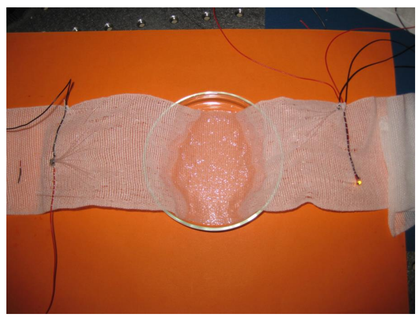
Interlaced fibers: in this configuration sensitive and reference fibers are integrated in the textile. The LED using the «mirror at 45°» configuration excites all the fibers. The light coming from each group of fibers is collected on 2 different photodiodes.

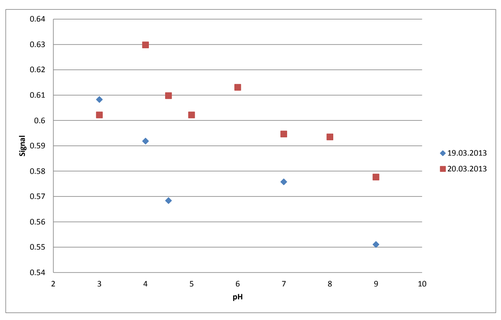


Independent sensing fibers: Textile sensing patch were realised incorporating 3 optical fibers. They are connected with the portable elctronics. The collected data can be recorded in the box or be sent wireless.

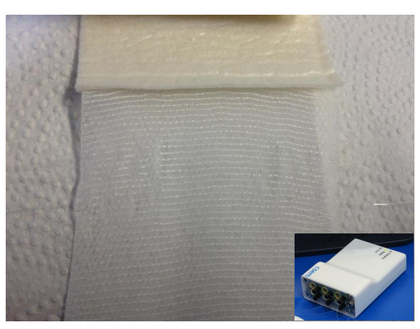
Realisations

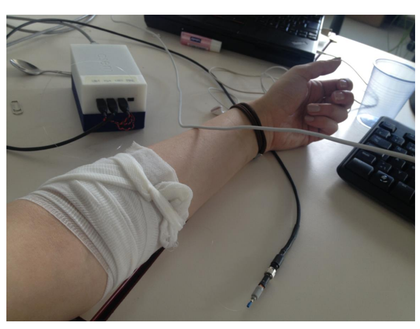


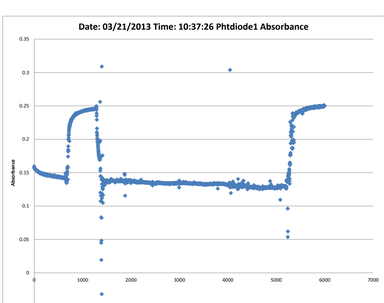




Interlaced fibers: A textile sensor was realised integrating pH sensitive fibers. It was possible to see change of signal with pH when the textile was immerged in different pH solutions.







Independent sensing fibers: The sensor patches have been used to demonstrate the simultaneous measurement of 3 pH fibers. First pH measurement on the skin have started.

Outlook

Direct coupling from electronic components to optical fibers inside textile will give the opportunity to develop fully integrated wearable optical sensors. Several methods were tested which have been tested with different sensor configurations. Promising results were obtained with pH sensitive optical fibers.