Silk fibroin based optical fiber devices

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Silk fibroin represents the most promising bio-material for optical devices. This work explores the development of optical sensors based on silk fibroin for several targets (e.g. alcohols).
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Bombyx mori silkworm fibroin is a popular protein polymer, nowadays widely used as a high-end textile fiber and originally used as surgical suture material. The simple processability of the regenerated form makes it very attractive in a range of biological applications, requiring superior mechanical properties, biocompatibility, biodegradability and facile-functionalization strategies. The above properties, combined with its high optical transparency make fibroin a promising material for the potential development of skin-attachable optical sensors. Recently, the use of silk fibroin was studied in a number of functional scattering, resonating photonic elements and volatile organic compounds optical sensor. [1] A summary of the work performed using the silk fibroin is presented, including results on the use of silk fibroin as a transducing material for organic vapors sensing; and preliminary results on the strain tuned behavior of Whispering Gallery Mode silk fibroin spheroid cavities.

Thin (less than 500nm), silk fibroin films have been drop casted onto the cladding of long period gratings (LPGs). This device configuration has been exposed to low molecular weight alcohols, at vapor pressure concentration, and the sensitivity of the silk fibroin enabled device has been studied; changes in both the strength and wavelength of the spectral notch of the LPG were observed. Greatest sensitivity results have been obtained for exposure of the sensing probe to methanol where a sensitivity of ~0.2nm/mbar was observed for a vapor pressure of ~100mbar. The sensor is insensitive to isopropanol while its sensitivity to ethanol is currently under investigation.

In addition, silk fibroin was drop casted onto spheroid cavities suspended onto silica glass supporting beams; light was trapped in these cavities using WG resonation, and studied in the Silk I and Silk II phases. An 8% wt silk fibroin solution [2] has been used to prepare microresonators that show Q factors (10^3 and 10^4 for Silk I and Silk II respectively, see Fig. 1) comparable with other WGM spheroid cavities casted from common polymers. The Silk I and II phase WGM cavities we subjected to longitudinal strain [3] and the corresponding perturbation of the WGM notches for TE and TM polarization was of the order of 3,8 pm/με.

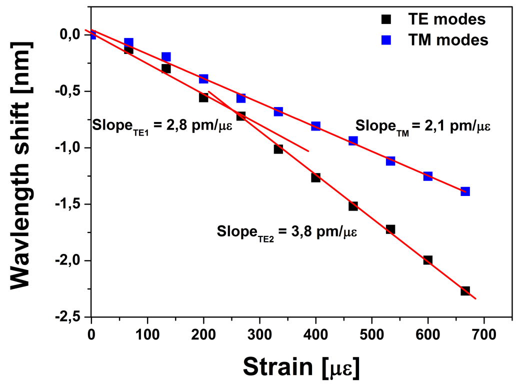

Fig.1 Perturbation of WGM for TE and TM polarization under longitudinal strain

Further work in carried out using this approach for estimating the photo-elastic coefficients of silk fibroin for the I and II phases; new results on this will be presented on-site.

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References

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