

Project III. 3

BIO-MICROSYSTEMS

Project Leader: K. Misiakos

Key Researchers: A. Tserepi, I. Raptis, E. Gogolides, P. Argitis, H. Contopanagos

Post-doctoral scientist: K. Kotsovos

Objectives:

- Development of bioanalytical lab-on-a-chip devices based on monolithic optoelectronic transducers (bioactivated optocouplers). Development of white light interferometric setup for label free monitoring of biomolecular reactions.

Funding

- EU, IST, STREP, "NEMOSLAB", NanoEngineered Monolithic Optoelectronic transducers for highly Sensitive and LAbel-free Biosensing (coordinated by K. Misiakos start 1-1-2006, end 31-12-2008)

RESEARCH RESULTS

- Optocoupler fiber tapering to micron dimensions and improved efficiency silicon LEDs.
- SU-8 microchannel integration on optocoupler chips.
- One dimensional protein based photonic crystal simulations towards label free detection of protein binding.
- Label-free protein detection through white light reflection interferometry

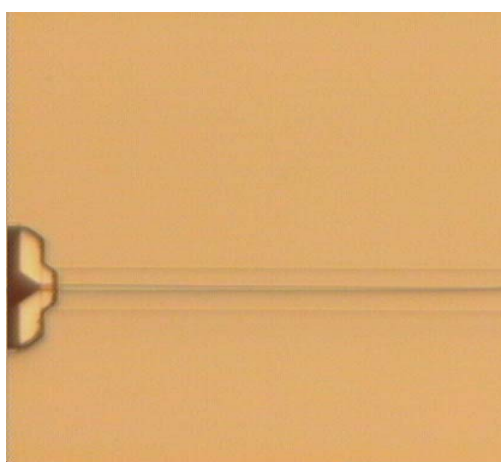


Fig.III.3.1: Optocoupler fiber tapering from 4 to 1 micron.

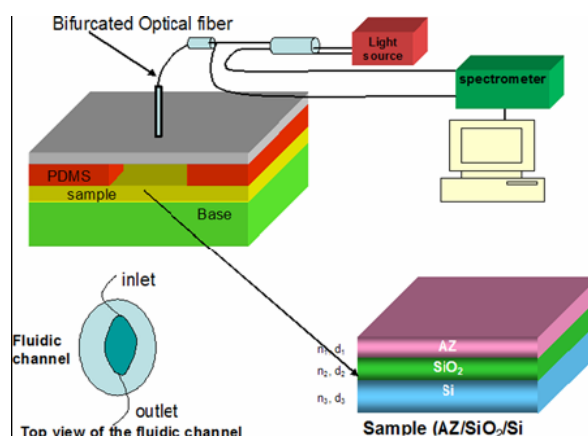


Fig.III.3.2: White light interferometric set up. The protein layer built-up is determined from the red shift of the main interference peak.

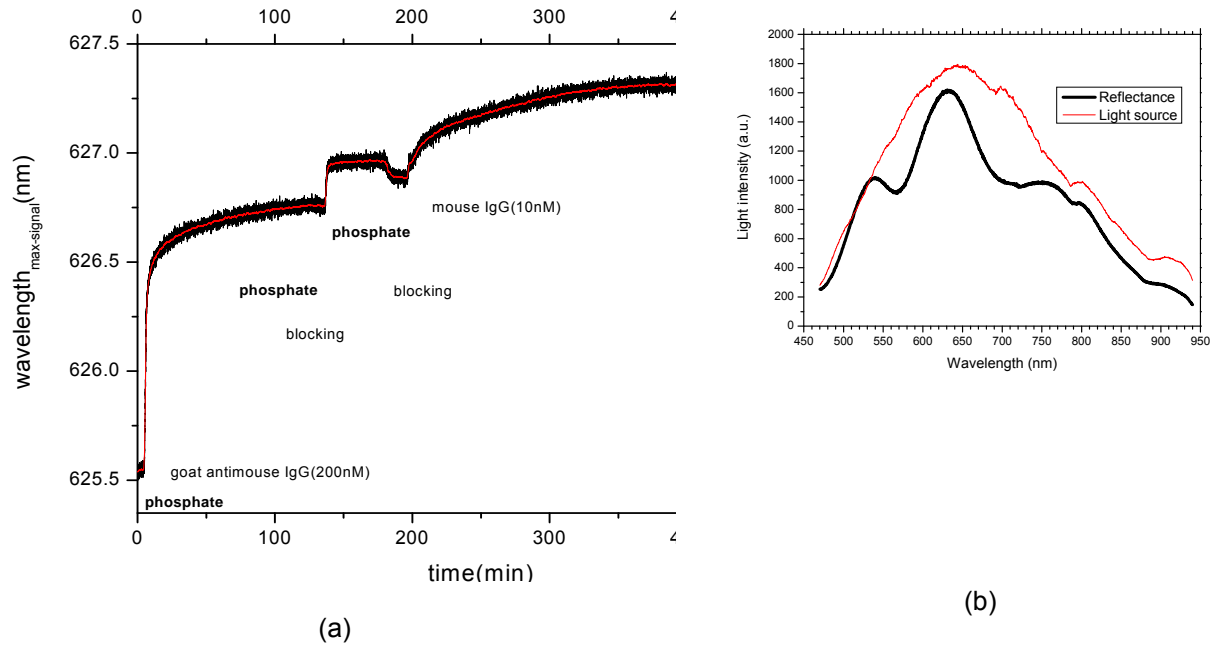


Fig. III.3.3: Protein coating (goat antimouse IgG), blocking, and reaction steps (mouse IgG) monitored by the set-up in Figure2 (a). The observable is the main interference peak wavelength (b).

Biomolecular interactions in real time by white light reflectance spectroscopy is demonstrated in Figure III.3.3. The experimental apparatus consists of a microfluidic channel for the supply of the biomolecular solutions placed above the sample on which the biomolecular interactions take place, and a reflection probe fiber to provide the probe beam on top of the sample through a glass window and guide the reflected beam to a spectrophotometer (Fig. III.3.2). The substrate used is a silicon wafer with a thick thermally grown silicon dioxide employed as the phase shift spacer to induce the interference pattern in the wavelength domain. Using this set-up it was possible to monitor in real time the protein film built-up during biomolecular coating, blocking and specific reaction to counterpart molecules. The biomolecular interactions were monitored as shifts of the wavelength of the main constructive interference peak and a formula was derived for translating these shifts into film thickness changes. The proposed methodology provides a simple, fast, low cost approach for a label free monitoring of biomolecular interactions. In future work, the study will be extended to other biomolecular interactions.

PROJECT OUTPUT in 2006

Publications in International Journals

1. "Label-free kinetic study of biomolecular interactions by white light reflectance spectroscopy", M. Zavali, P.S. Petrou, S.E. Kakabakos, M. Kitsara, I. Raptis, K. Beltsios and K. Misiakos, *Micro & Nano Letters*, Volume 1, Issue 2, p.94-98, 2006
2. "Monolithic silicon optoelectronic transducers and elastomeric fluidic modules for bio-spotting and bio-assay experiments", Misiakos, K., Petrou, P.S., Kakabakos, S.E., Vlachopoulou M.E., Tserepi A., Gogolides E., Ruf, H.H., *Microelectron. Eng.* 83, 1605-1608, 2006.
3. "Biochip-compatible packaging and micro-fluidics for a silicon opto-electronic biosensor", Ruf H.H., Knoll T., Misiakos K., Haupt R.B., Denninger M., Larsen L.B., Petrou P.S., Kakabakos S.E., Ehrentreich-Foerster E., Bier F.F. *Microelectron. Eng.* 83, 1677-1680, 2006.

Paper in International Conference Proceedings

1. "Monolithic silicon optoelectronic devices for protein and DNA detection", Misiakos, K., Petrou, P., Kakabakos, S.E., Vlachopoulou, M., Tserepi, A., Gogolides, E. (Invited Paper) *Proceedings of SPIE - The International Society for Optical Engineering* 6125, art. no. 61250W (2006)

International Conference Presentations

1. "Biomolecule friendly photolithographic process for sub-micron resolution patterning of proteins", Petrou P.S., Chatzichristidi M., Douvas A.M., Argitis P., Misiakos K., Kakabakos S.E., *Biosensors 2006*, Toronto Canada May 10-12, 2006. Abstract book P367.
2. "A bioanalytical microsystem based on a monolithic silicon optoelectronic transducer for real-time and label-free determination of multiple analytes", Petrou P.S., Mavrogiannopoulou E., Kakabakos S.E. Misiakos K., *Biosensors 2006*, Toronto Canada May 10-12, 2006. Abstract book O88.
3. "Photolithographic process based on high contrast acrylate photoresists for multi-protein patterning", Chatzichristidi M., Petrou P.S., Douvas A., Diakoumakos C.D., Raptis I., Misiakos K., Kakabakos S.E., Argitis P. *MRS Fall Meeting 27 November-1 December 2006*, Boston, MA, USA. Book of Abstracts p. 96. D15.15.
4. "Biofluid transport on hydrophobic plasma deposited fluorocarbon films", Bayiati P., Tserepi A., Petrou P.S., Kakabakos S. E., Misiakos K., Gogolides E., *32nd International Conference on Micro- and Nano-Engineering, MNE 2006*, 17-20 September 2006, Barcelona, Spain. Book of abstracts p. 113, 4A – Micro- and Nano-systems for Biology 2.
5. "A novel process for irreversible bonding of PDMS and PMMA substrates", M.E. Vlachopoulou, Tserepi A., Misiakos K., *32nd International Conference on Micro- and Nano-Engineering, MNE 2006*, 17-20 September 2006, Barcelona, Spain. Book of abstracts p. 421 – Microsystems and their fabrication.
6. "Electrowetting-based fluidic transport on hydrophobic fluorocarbon films deposited in plasma", Bayiati P., Tserepi A., Petrou P.S., Misiakos K., Kakabakos S. E., Gogolides E. *5th International Electrowetting Meeting*, 31 May-2 June 2006, University of Rochester, New York, USA. Book of Abstracts

Greek Conference Presentations

1. "Label free kinetic study of biomolecular interactions by white light reflectance spectroscopy", Zavali M., Petrou P.S., Kakabakos S.E., Kitsara M., Raptis I., Beltsios K., Misiakos K., *XXII Greek Conference on Solid State Physics and Material Science*, September 24-27, 2006, Patra. Book of Abstract p.106.
2. "Simultaneous detection in real time of different BRCA1 gene mutations using a monolithic silicon optoelectronic transducer", Mavrogiannopoulou E., Petrou P., Sifaka-Kapadai A., Christofodis I., Misiakos K., Κακαμπάκος Σ.Η. « *6th Greek Conference in Clinical Chemistry-Clinical Biochemistry*, Athens, November 9-11 . Book of Abstracts p. 171.
3. "Label free kinetic study of biomolecular interactions by white light reflectance spectroscopy", Diploma Thesis at Institute of Microelectronics at NCSR Demokritos for Materials Science and Engineering department of University of Ioannina (October 2006)

Patent filing:

"Multianalyte biosensors based on monolithic optoelectronic transducers", PCT application, Filing No.: PCT/GR06/000069, Filing date: 27/12/2006, Priority: 20050100623/ 27-12-2005