Photonics and nanomechanical biosensing devices for early medical diagnostics

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Nowadays most of the tests for diseases detection are based on time-consuming, expensive and sophisticated techniques which can only be done by specialised technicians in laboratory clinical environments. Usually those tests require sampling and labelling with fluorescent or radioactive labels. Micro/Nanobiosensors can offer early diagnostic tools of better sensitivity, specificity and reliability which could improve the effectiveness of in vivo and in-vitro diagnostics. They also offer the possibility of taking different measurements in parallel or to integrate several analytical steps from sample preparation to detection into a single miniaturized device (what is called "lab-on-a-chip" platform). For these reasons, our Group is focus in the development of micro/nanosensors based on photonic and nanomechanical principles which operate in real-time and in a fast and label-free scheme. The biosensors have been applied for DNA and immunological testing. Three types of biosensors have been implemented:

(i) A portable Surface Plasmon Resonance sensor which has been applied to the real-time and label-free detection of DNA single point mutations. We have simultaneously detected in a multianalyte format four relevant mutations at the gene BRCA-1, related to the predisposition in women to develop an inherited breast cancer.

(ii) Ultrasensitive and miniaturised photonic silicon sensor based on integrated optical waveguides. As sensors we use integrated Mach-Zehnder interferometer based on TIR waveguides ($Si/SiO_2/Si_3N_4$) of micro/nanodimensions which are monolithically integrated with a 3D-polymeric microfluidic network. For DNA detection, the sensor shows a limit of detection in the pM range for fully hybridisation and in the nM range for single mutations.

(iii) Nanomechanical biosensor based on standard microcantilevers and on waveguided microcantilevers which we have recently introduced as a new type of read-out technique. The microcantilever devices have been integrated in a microsystem platform with 20 independent measurement channels.