Optical resonance-based biosensors designed for medical applications

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Abián Bentor Socorro-Leránoz, a telecommunications engineer of the NUP/UPNA-Public University of Navarre, has designed optical resonance-based biosensors for use in medical applications like the detection of coeliac disease. Besides achieving greater resolution and sensitivity, the materials used in these devices are much cheaper and more versatile than the ones used in current technologies (mainly gold and noble metals), so they could offer a potential alternative in the design of biomedical sensors.

A biosensor is an instrument that uses biological molecules (bioreceptors) to detect other biological or chemical substances. In this thesis, the bioreceptors are antibodies, biological molecules that the body produces specifically to fight off antigens. An antigen is a substance foreign to the human body; our immune system recognises it as a threat, and in the presence of it, the body reacts by producing antibodies to identify and neutralise it. What is more, the biosensor is made up of a substrate where the physical phenomenon that translates the biological reactions into intelligible information takes place, and the immobilisation layer, which causes the antibodies to become attached to the substrate.

"One of the unique features is that for the substrate we use silicon waveguides on which we generate a specific type of resonance," says the author. The biosensors are based on the movement of the wavelength of the resonances generated on the basis of the quantity of antigens detected. "When the antibodies come together with the antigens, there is

a minimum change in the wavelength that our biosensors are capable of picking up."

This is possible thanks to the resolution achieved by these biosensors and their sensitivity, "which enables us to see how much resonances shift on the wavelength as the antibody-antigen links increase."

Medical application

The work carried out by Abián Socorro is geared toward medical applications. Basically, the more antigens that are detected in the sample, the more advanced the disease is. "This is what we would see: If you are in an early or late phase, you will have few antigens and few antibodies, so the resonance will move toward wavelengths closer to the reference ones. If the phase is more advanced, the concentrations detected will be higher, so the resonance will change a lot in the wavelength," he explained.

The technology used is based on LMRs, lossy mode resonances, in which the Sensors Laboratory of the NUP/UPNA-Public University of Navarre is a pioneer. "This technology has shown itself to be a potential competitor of the one based on SPRS (surface plasmon resonances) which currently dominates most biosensor applications".

This work is about optimizing the parameters of the optical waveguides used to generate resonances that provide the maximum possible resolution and sensitivity, a crucial aspect in the field of biosensors. The research conducted has resulted in two awards at the international conferences Trends in Nanotechnology 2012 and Optical Fibre Sensors 2014. In the latter conference, the biosensor was designed to detect coeliac disease and when compared with the usual values in the clinical environment succeeded in reducing the concentration of antibodies detected to diagnose this disorder.

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