Optical Biosensors to Explore Biological Systems

The study of live biological systems requires the use of advanced techniques that provide high structural and chemical information and at the same time, avoid damage in the system and modification of the structural/chemical features. Techniques based on interaction with light have shown their capability to work in biosensor devices. For example, Raman spectroscopy can be non-invasive and can provide 1 μm of spatial resolution in 1 second of collection time, well suited for sensing. Moreover, it may give information at the single cell and even approaching the single molecule scale. Here we present the capability of different light based techniques for biosensing.

As the first example, surface enhanced Raman spectroscopy (SERS) is performed in onion using silver plasmonic nanostructures. Our studies detect different molecular compounds present in the plant based on their SERS signals. SERS imaging allows us to monitor the location of nanoparticles and to image chemical compounds within the target. Moreover, a pH-sensitive reporter molecule, pMBA attached to the silver nanoparticles, is used to infer pH values in the extracellular space of an onion layer.

As a second example, we explore how a membrane protein may be used as an efficient sensor in an organic environment via a biomimetic membrane model. The combination of both biomimetic membranes and protein membranes as a signal transduction medium has interesting applications in biology and medicine. It is crucial that the matrix where a protein is embedded is optimal in order to maintain the concentration gradient. Moreover, curvature and mechanical forces in the membrane may also affect the protein function. In this work, by inducing chemical and mechanical changes of the matrix we optimize the system via measuring variations of the gradient through the membrane.