Development of novel plasmonic biosensors for detection of tumoral biomarkers and exosomes

In Europe, prostate cancer (PCa) is the most common male cancer affecting approximately 400,000 men annually. Due to this, the development of sensitive, versatile and non-invasive biosensors for differentiating between different stages of PCa represents an urgent need in the management of PCa.

The hypothesis that extracellular vesicles (EVs) are increased in biofluids like urine from PCa patients, makes these EVs very interesting as biomarkers to study PCa progression. The current workflow with exosomes involves their purification and characterization through time consuming and far from being efficient techniques. For EVs quantitation, the most commonly used assay is the ELISA, which currently is being replaced by lab-on-a-chip devices due to advantages such as the small amount of sample required, shorter processing times and the improvement in sensitivity. Particularly, the lateral flow Immunoassays (LFIA) highlight for allowing an unskilled operator to detect low amounts of analyte without the need of previous purification being so useful in medical diagnosis.

In this work, we propose the development of an ultrasensitive thermal transduction biosensor based on LFIA using gold nanoprisms (AuNPrs) functionalized with antibodies that recognize canonical exosomal biomarkers and the prostate-specific membrane antigen (PSMA), for detecting PCa exosomes directly in urine. The AuNPrs present an optical property known as surface plasmon resonance which provides them with the ability to transform the light into thermal energy when a light source from the near-infrared falls upon them, increasing the sensitivity of the biosensor.

To reach this goal, different antibody pairs capable of detecting the canonical markers CD63 and CD9 and the prostate-specific marker PSMA in human samples were selected. The biosensor consists on a sandwich immunoassay where anti CD63 is immobilized on the nitrocellulose strip as capture antibody. Anti-CD63, anti-CD9 or anti-PSMA biotinylated antibodies linked to streptavidin coated AuNPrs act as detection system. LFIA assays have been performed testing urinary derived exosomes from healthy donors and PCa patients. By irradiating the AuNPrs with a laser, we have been able to increase the sensitivity with respect to a classical LFIA already published, detecting low amounts of exosomes in the LFIA strips and to differentiate between healthy donors and patients.