VACMON: Vaccine monitoring biosensor

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VACMON* is an ongoing project that stands for an impedimetric biosensor platform able to assess and quantify the immune response after a vaccination. The biosensor, based on hybrids biomolecule-nanoparticle, has as main objective to develop a portable device capable of providing real-time individualized profile of the immune response from a small blood sample. Both national and international public health programs, are working to reduce human papilomavirus (HPV) vaccination costs maintaining its effectiveness and safety. Taking into account the great negative impact caused by this virus, the quadrivalent vaccine against HPV has been chosen for the development of the biosensor device as a model for vaccine monitoring proof of concept.

Our device will be able to quantify the response of the immune system against HPV after vaccination detecting specifically the full-length of the external proteins that form the capside of the HPV (L1), proteins from the HPV types 6, 11, 16 and 18, which are the most incident and aggressive types. Thus, the biosensor will provide information on the maintenance of immunogenicity induced, as well as enabling the identification of people who present a pre-existing immunity, and therefore do not require vaccination or require a different schedule of vaccination.

The biosensor design consists in interdigitated gold microelectrodes design on glass wafers fabricated by photolithography and lift-off processes. Biomolecule-nanoparticle hybrids are covalently attached to the glass surface between the electrodes. Those hybrids consist on gold nanoparticles (Au-NP) functionalized with the most immunogenic regions of the L1 protein of each HPV type. Au-NP increase the active surface area, amplify the label-free impedimetric signal and, thus, enhancing the sensitivity of the biosensor. HPV specific antibodies from a blood sample recognize the L1 fragment attached to the biosensor thus acting as a barrier against the free displacement of ions between both electrodes, leading to a change in the electrical impedance. The two-step functionalization process and the possibility to use directly non-treated blood samples, converts this biosensor platform into a versatile system able to quantify the immune response to other vaccines.

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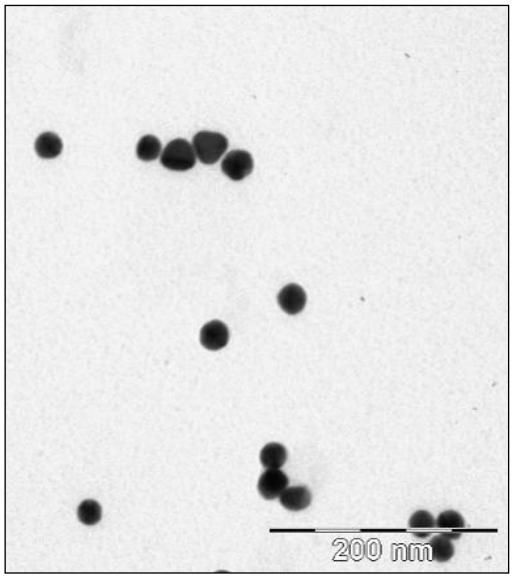

Fig.1: TEM image of Au-NP

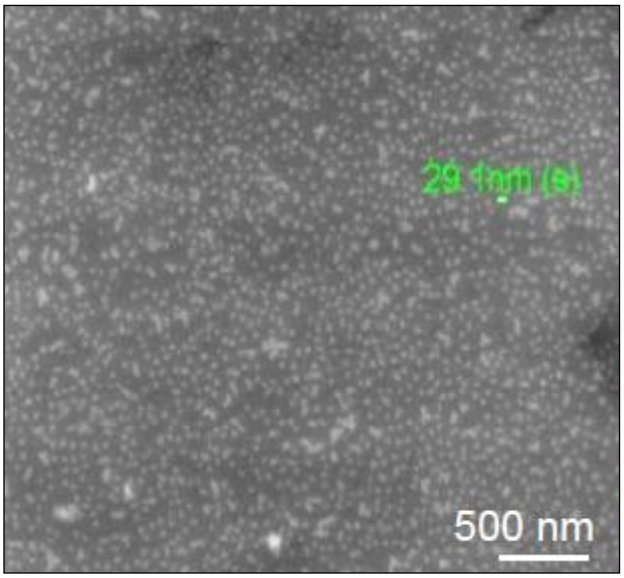

Fig.2: SEM image of Au-NP covalently attached to the biosensor surface.

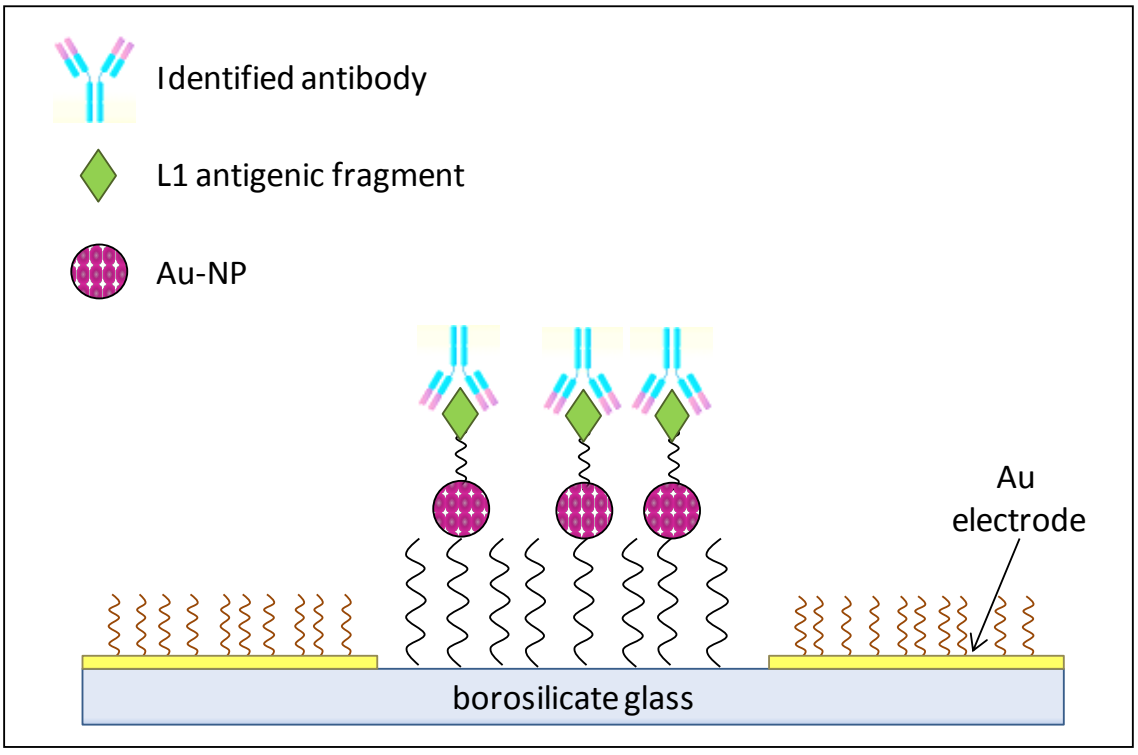

Fig.3: Schematic representation of the biosensor platform