GRAL PhD PROJECT 2020-2023

Title of the PhD project: Structural characterization of engineered Virus Like Particles using nanoresonator-based mass spectrometry

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Summary of the project: Considering the current surge in antibiotic resistance, vaccination could one day become the ultimate preventative measure against infectious diseases. However, conventional vaccine development strategies are slow and outdated, and radically novel approaches are urgently needed to improve vaccine stability, decrease development time, and alleviate public concerns with side effects and inefficacy. Engineered virus-like particles (VLP) are emerging as safe, efficacious, stable, and versatile antigen presentation platforms for vaccine applications. However, the structural characterization of such supramolecular assemblies composed of several millions of atoms is highly challenging. Actually, no commercial MS system operates in the mega- to giga-Dalton mass range required for VLP analysis. For this purpose, we are developing a novel nano-resonator mass spectrometry (MS) technology and applying it to the characterization of VLP. The objective of this PhD will be to utilize this innovative methodology to establish relationships between VLP mass profiles and their structural and immunological properties in order to achieve real time assessment of VLP integrity, stability, and antigen grafting efficiency in a single analysis.

Keywords: Virus-like particles (VLP), vaccine, nanoresonator, mass spectrometry, structural analysis

Applicant profile: The successful candidate should have a background in analytical chemistry, nanocharacterization, and/or structural biology. Prior experience in native mass spectrometry would be highly valued. Applicants should provide evidence of academic performance, excellent English writing and communication skills, and a commitment to work on scientifically challenging problems. They must also have a taste for multidisciplinary teamwork.

Three recent publications of the PhD supervisors

Sage E. et al. Neutral particle mass spectrometry with nanomechanical systems. Nat. Commun, 2015, 6: 6482 / DOI:10.1038/ncomms7482

Sage E. et al., Single-particle mass spectrometry with arrays of frequency-addressed nanomechanical resonators. Nat. Commun., 2018, 9: 3283 / DOI: 10.1038/s41467-018-05783-4

Dominquez-Medina S. et al., Neutral mass spectrometry of virus capsids above 100 megadaltons with nanomechanical resonators. Science, 2018, 362: 918 / DOI: 10.1126/science.aat6457