Summary

This thesis focuses on the development of a new kind of versatile biosensor based on spectroscopic device. In this work, we will show the utility of Fourier Transform Infrared (FTIR) spectroscopy in Attenuated Total Reflection (ATR) mode through a variety of biosensing applications. We will first present the original biosensor device, named BIA ATR (Biochemical Interaction Analysis - Attenuated Total Reflection) as initially developed while showing the first biosensing successes.
The high potential of this new spectroscopic sensor will be proved through the study of a model for hapten molecules named the Dinitrophenol (DNP). We will show how an efficient strategy based on competition of molecules allow to provide useful signal amplification to detect very small molecules like DNP. The results obtained have given rise to the new competitive immunosensors based on FTIR-ATR spectroscopy that are able to provide useful information such as affinity constant of the used antibodies.
Then, we will present a method of functionalization for ATR element based on wet chemistry. Here, we will give some details about the design, the synthesis, and the validation of a promising organic layer that lays the foundations for the construction of novel FTIR biosensors particularly to work in complex media. Furthermore, we will also report a promising method to quickly realize the organic layer of our ATR elements via a one-step procedure.
In addition, biosensors developments require to design a complete system that will be configured to allow semi-continuous flow analysis including a microfluidic cell usable in ATR configuration and a peristaltic pump with adequate tubings. We will see how our FTIR ATR biosensor can be miniaturized and integrated into an interesting lab-on-chip tool using an appropriate shaped ATR element mainly to minimize the cost of use.
Finally, we will demonstrate the interest of this new organic covering through the development of powerful immunosensor allowing direct detection in complex media. We focused here on the detection of toxin called Verrucarin A (VerA) in dust samples coming from an environmental indoor collecting. Finally, we will prove the ability for our spectroscopic immunosensor to detect VerA in human urine samples for assessing VerA exposure.