# CHAPTER V

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

In this work, polyelectrolytes have been used to encapsulate silver nanoparticles. The electrostatic properties of the polyelectrolytes were used to primarily provide the stabilization of the nanoparticles by electrostatic repulsion and then allow their assembly using the layer-by-layer technique. Nanoparticles prepared this way display the characteristic LSPR located at 400 nm which is a signature of the successful preparation of silver nanoparticles. TEM was also used to confirm the nanosize of the silver nanoparticles prepared with this method. Due to electrostatic stabilization the nanoparticles solution appeared stable and then their sensing properties were tested a first time in solution against 4 organic compounds namely methanol, ethanol, propanol and acetone. The nanoparticles prepared from solution containing a minimum amount of polyelectrolytes displayed a red shift of their initial spectra when exposed to solution containing organic compounds. In contrast, nanoparticles prepared from solutions containing higher polyelectrolyte content did not show any change in their UV-Vis spectra probably due to the hydrophilic character inherent to polyelectrolyte coatings. The nanoparticle prepared with the least amount of polyelectrolytes also displayed a better adsorption into monolayers when compared with other nanoparticles. The adsorption onto a glass or quartz slide coated with polycationic polyelectrolytes was monitored as a function of time and under various conditions. The two parameters on interest when looking at the adsorption of nanoparticles were identified as the kinetic of adsorption and the saturation level. The first parameter define how fast the nanoparticles adsorb as a function of time and the second parameter define how much of silver nanoparticle adsorb onto the surface after the deposition process is finished. Factors controlling the kinetic and the saturation level were identified as the concentration in nanoparticles, the ionic strength of the solutions, the amount of polyelectrolytes used in the preparation of the nanoparticles and the type of polyelectrolytes used. The assembly of the nanoparticles was then pushed from the level of monolayer to the level of multilayer by alternating dipping of a substrate in solutions containing either a polycationic polymer or the polyanionic nanoparticles. The growth of films formed of up to 10 layers was monitored by taking UV-Vis spectra of the substrate after each dipping step. A linear growth was observed for all solution but the increments of increase in optical absorbance were found to be the greatest for nanoparticles assembled from 0.5 mM polyelectrolytes. A competitive adsorption mechanism was used to justify the lower adsorption potential of nanoparticles prepared from higher polyelectrolyte content. Finally the optical sensing of the assembled nanoparticle into thin films were again tested against organic compounds namely methanol and ethanol. While film from 0.1 mM alginate nanoparticles were sensitive to increasing ethanol or methanol content, no clear distinction between the two compounds could be made. It is suggested that the dielectric difference between the two compounds is too small to be detected by the change in UV-Vis spectra of the surface plasmon resonance of the silver nanoparticles. Nevertheless some selectivity to this system could be introduced by surface modification of the nanoparticles sensor thin films by secondary coating with few layers of PDADMAC/PSS polyelectrolyte multilayers. It was found that three layers of PDADMAC/PSS film were sufficient to selectively block the methanol and allow the ethanol to reach the sensors.

### 5.2 Recommendations

More work is clearly needed in order to tune the response of the nanoparticle composite thin film by modifying the type of coating. The coating used here was prepared by the simple deposition of a very commonly used polyelectrolyte pair which is PDADMAC and PSS. This pair is very often used because extensive literature exists on its properties and they also present the advantage of being extremely stable in various solvent and under a wide range of pHs. Nevertheless many other types of PEM could be used and the sensor response could be modified by the type of Polyelectrolytes pairs used. Also more work could be done by developing more complex architecture in order to have multiple sensors which would have the potential to detect a specific chemical. Using groups of sensors multiplexed for example onto fiber optic surface and combining their response with neural network, the fabrication of electronic tongue or electronic nose should be possible. Most of these experiments could be extended to other metals such as gold or copper which also present LSPR in the visible range. The combination of gold nanoparticle and silver nanoparticle could lead to the fabrication of multistage sensors.