Dynamic pH Sensing in Micro-fluidic Devices Using Adaptive Coatings Based on Polyaniline

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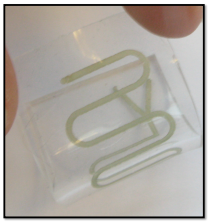
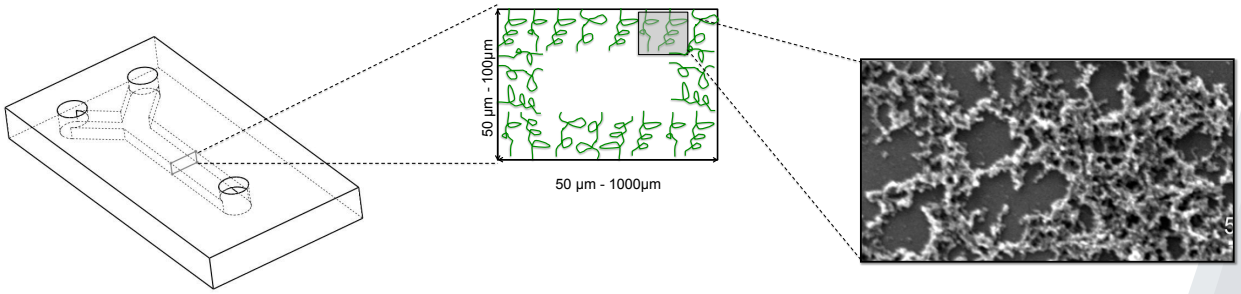


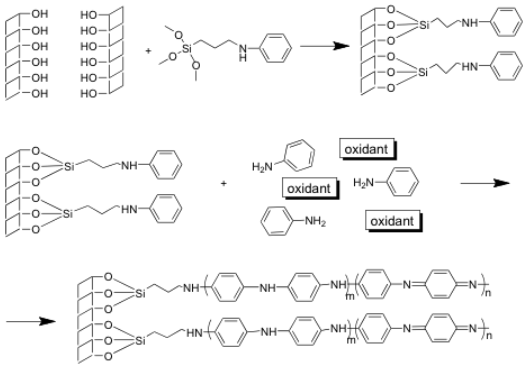
➢ Introduction

In recent years, a number of optical pH sensors have been developed because they offer advantages in terms of size, costs, and response time. In particular, conducting polymers have been used to prepare optical pH sensors. Among these conducting polymers, polyaniline (PAni) has received significant attention because of its suitability over a wide pH range of operation. By focusing on PAni nanofibres we can dramatically increase the surface area of the material, which manifests in improved response times and sensitivity. Therefore our approach presents a new, simple, and fast photometric method to measure pH using PAni based coatings in micro-channels. The pH measurement can be carried out in continuous flow mode by using fiber-optic light guides.



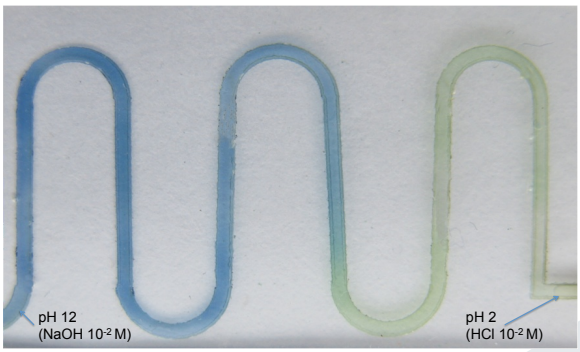
Polymer brushes based on the conducting polymer polyaniline were synthesised on the interior walls of micro-fluidic devices.

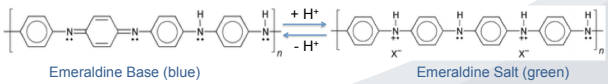
➢ Micro-channel Functionalisation Process



The polyaniline brushes were formed using a "grafting from" approach.

➢ Sensing pH gradient



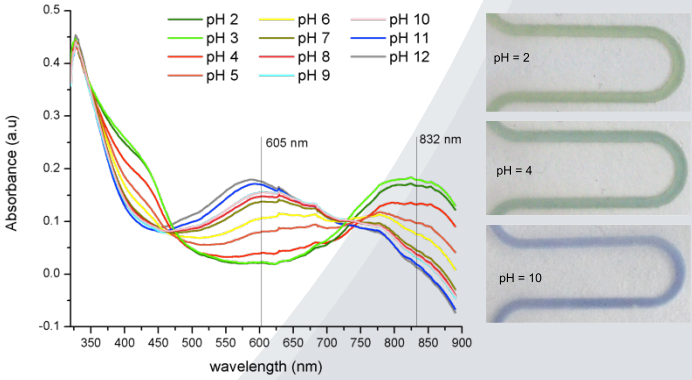


Emeraldine Base (blue) — Emeraldine Salt (green)

The polyaniline coatings present the ability to change between the emeraldine salt form of PAni (green) to the emeraldine base form (blue) when a solution of HCl 10^{-2} M, NaOH 10^{-2} M respectively, is flushed inside the channel. Moreover, the PAni coatings shows dynamic response throughout the entire length of the channel.

➢ UV-Vis spectroscopy

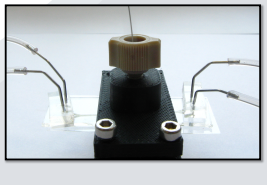
UV–vis spectra of polyaniline are sensitive to the conjugation and conformation of aniline rings that vary upon changes in the surrounding pH in solution. The emeraldine estate exhibits a strong absorbance band at approximately 605 nm, which is attributed to the quinoid excitation absorption. Upon doping, the quinoid transition disappears, and new absorbance bands appear at about 420 nm and 832 nm.

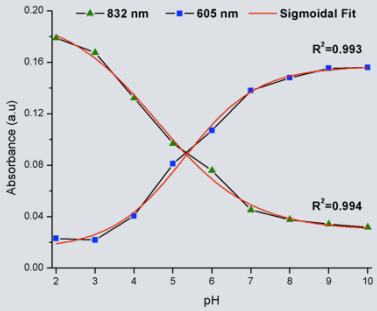


The optical/electrical proprieties of these polyaniline coatings change in response to the pH of the solution that is flushed inside the micro-channel.

➢ Dynamic pH sensing

The pH measurement is done in continuous flow mode using fiber-optic light guides.





➢ Conclusions

Polyaniline brushes coatings offer the possibility of monitoring pH in continuous flow over a wide pH range and all over the channel length, being extremely interesting technique to monitor pH dependent chemical reactions in micro-fluidic devices.

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