

Larisa Florea, Emer Lahiff, Dermot Diamond and Fernando Benito-Lopez

CLARITY: Centre for Sensor Web Technologies, National Centre for Sensor Research, School of Chemical Sciences  
Dublin City University, Dublin 9, Ireland

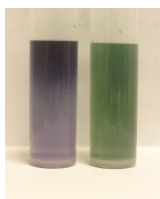
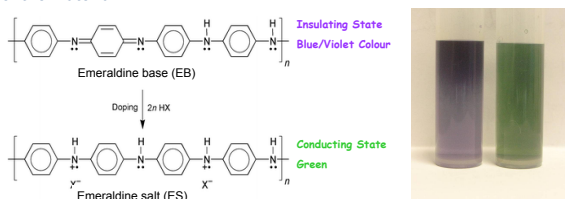
larisa.florea2@mail.dcu.ie

## Introduction

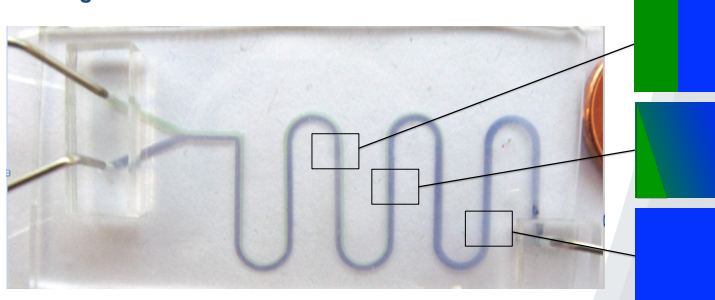
Lab-on-a-chip technology is attracting great interest as the miniaturisation of reaction systems offers practical advantages over classical bench-top chemical synthesis. Therefore the understanding and proper evaluation of the flow and mixing at microscale becomes a very important issue. Easy accessible tools that allow to monitor mixing behaviour during a chemical process in a non invasive way are of great interest in the chemical industry. Here, we present the specific mixing and fluidic behavior of two reacting solutions of HCl and NaOH in a glass/PDMS micro-fluidic device as an example of the power of adaptive coatings based on the conductive polymer, polyaniline (PAni). The optical properties of polyaniline, which is pH dependent, can be used to study mixing in micro-fluidic devices when using solutions of different pHs and monitor, for instance, the evolution of neutralisation reactions.

## Polyaniline Nanofibres

PAni is a conducting polymer whose properties (optical/electrical) change in response to changes in the immediate environment of the material. By focusing on PAni nanofibres we can dramatically increase the surface area of the material.



## Mixing Process



Mixing was studied using colorless hydrochloric acid ( $10^{-2}$  M, pH=2) and sodium hydroxide ( $10^{-2}$  M, pH=12) solutions pumped through the two arms of the Y-shaped micro-channel,  $1000 \times 100 \mu\text{m}$  and 110 mm long. The two liquid streams meet at the Y-junction, and mix in a particular area of the micro-channel according to a defined time given by the flow rate, which was varied between  $0-14 \mu\text{L min}^{-1}$  for each of the flows.

## Micro-chip Fabrication

PDMS is spun onto master mold, cured at  $80^\circ\text{C}$  for 1 h and removed from the mold.



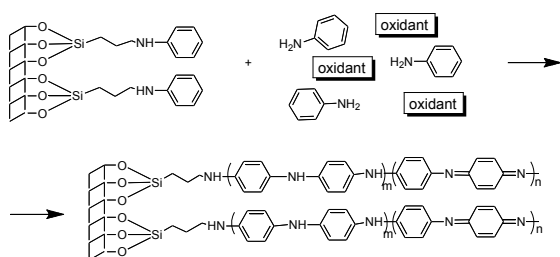
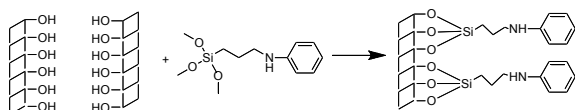
PDMS and glass slide are treated with oxygen plasma.



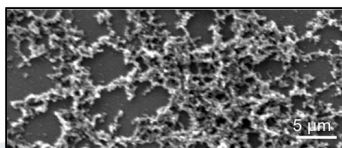
PDMS and glass slide are brought together.



## Micro-channel Functionalisation Process



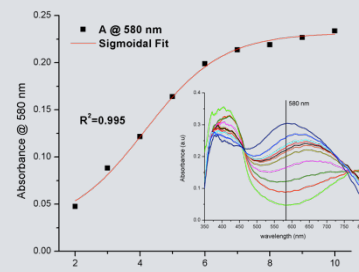
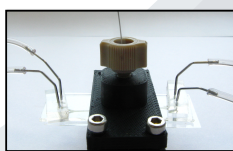
## PAni Coatings



Scanning Electron Microscopy image of the PAni brushes inside the channel shows that the nanomorphology of the polymer is maintained inside the channel.

## pH dependent coatings

The PAni spectra is highly pH dependent and changes from green to blue. A graduate changes behavior from pH 2 to 10 has been observed, showing that these type of coatings can be used to monitor neutralisation reaction in micro-fluidic devices.



## Conclusions

This approach can be used for investigating diffusion and mixing processes of solutions in micro-channels.

It obtains useful information for the optimal design of micro-reactors for chemical synthesis applications.

The coatings can be employed as indicators in the case of neutralisation reactions due to the propriety of polyaniline to change its optical properties in response to changes in pH.

## Acknowledgements

Irish Research Council for Science, Engineering and Technology (IRCSET)-Embark Initiative and Science Foundation Ireland under grant 07/CE/1147.