THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND
ENGINEERING
DEPARTMENT OF CHEMICAL AND MATERIALS ENGINEERING

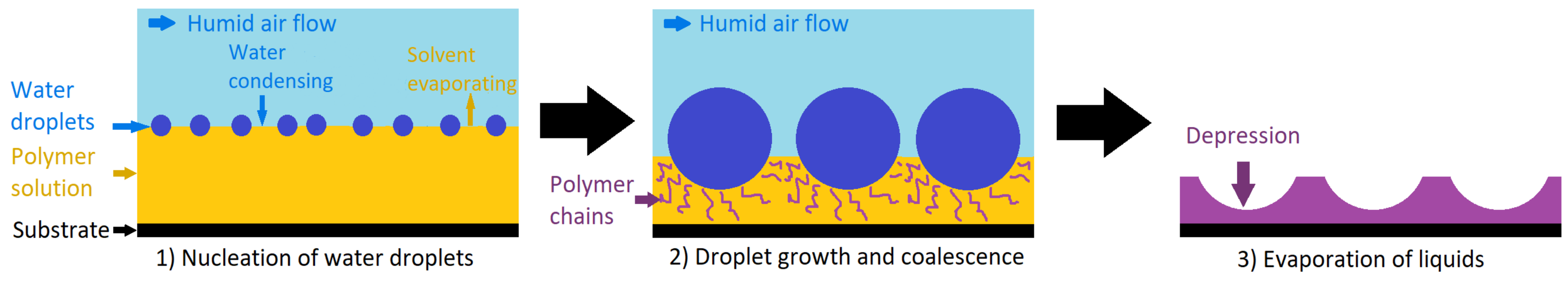
Controlling breath figure patterns on P3HT films by altering humidity during spin coating

Victoria Pickett**, Alisyn J. Nedoma**
**Department of Chemical and Materials Engineering, University of Auckland, Auckland 1142, New Zealand

Introduction

Plastic solar cells have a high flexibility, low cost and low energy of production but are lacking in efficiency. The active layer is generally made up of a thin film of two conducting polymers – an electron donor and an electron acceptor. By controlling the humidity during the formation of this polymer film it is possible to create a pattern of depressions called breath figures which could enhance light-trapping properties.

Flexible plastic solar cells created by Eight19



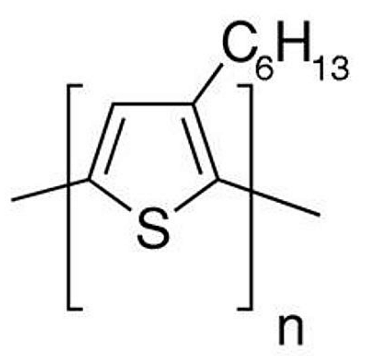
The mechanism of breath figure formation (simplified)

Objective

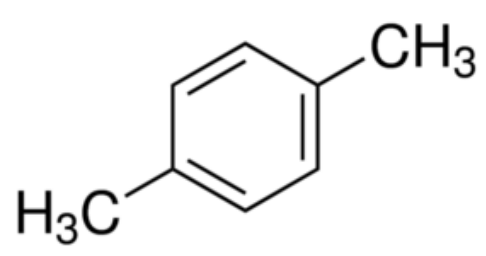
To investigate the effect of humidity on breath figure formation of thin conducting polymer films

Materials

Poly(3-hexylthiophene) (P3HT)
Conducting organic polymer commonly used as the electron donor in plastic solar cells
p-xylene
Solvent used during P3HT film preparation

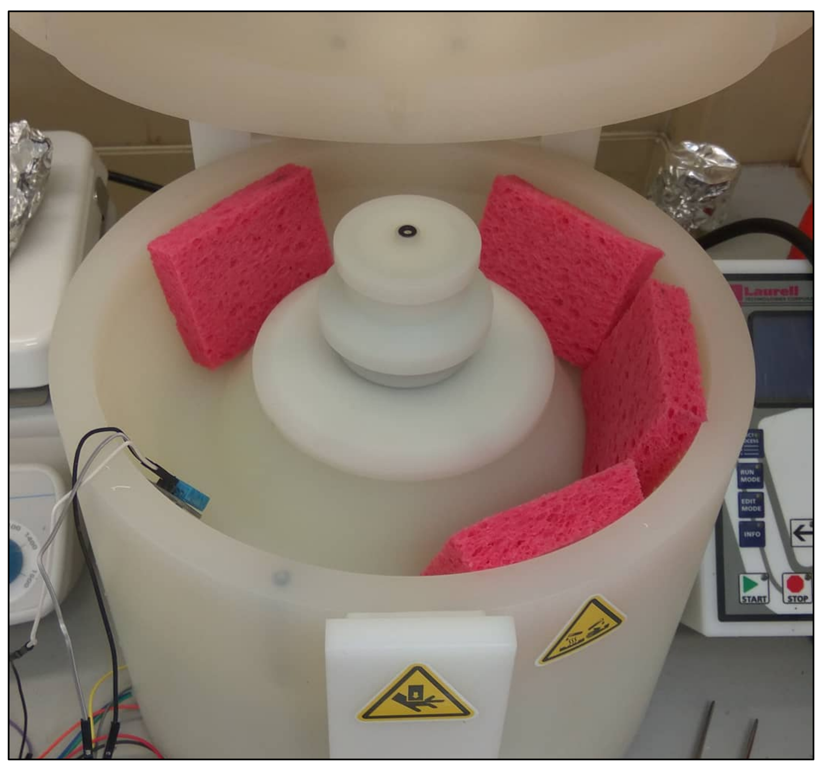


P3HT



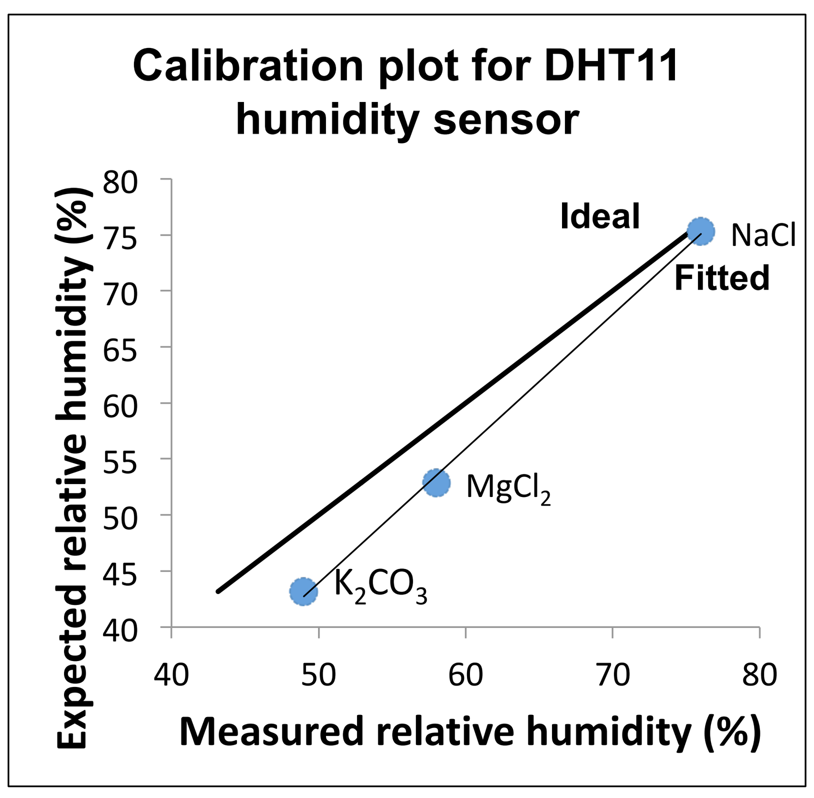
p-xylene

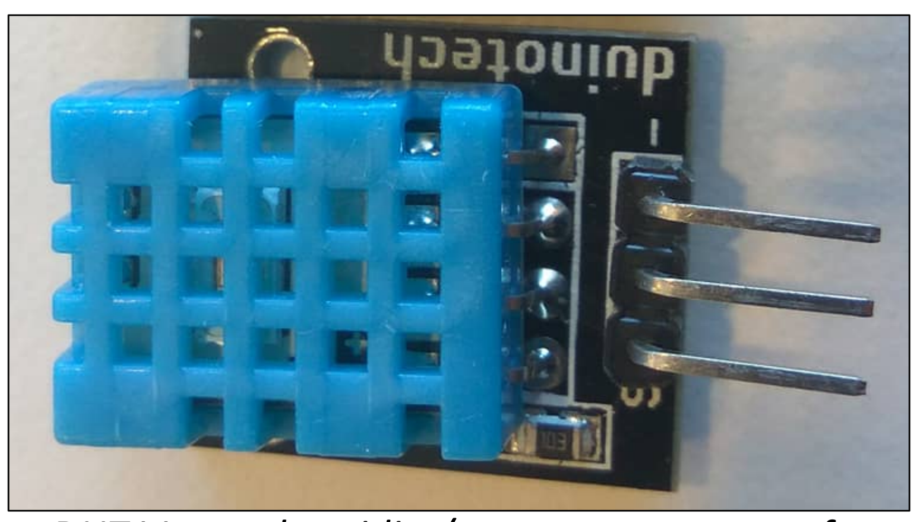
Equipment and Method



Spin coater containing warm, saturated sponges to alter humidity and a DHT11 humidity/temperature sensor

- The P3HT solution in p-xylene was spin coated onto Ultra-Violet Ozone (UVO) treated silicon wafers after 14 days of ageing
- Spin coating involves placing the P3HT solution onto the silicon and spinning so that the solution spreads out and the p-xylene evaporates
- The humidity sensor was built as part of this project and was calibrated by using saturated salt solutions to give atmospheres of known humidity and fitting a line to the measurements
- The films were examined using optical microscopy and the images were analysed using ImageJ



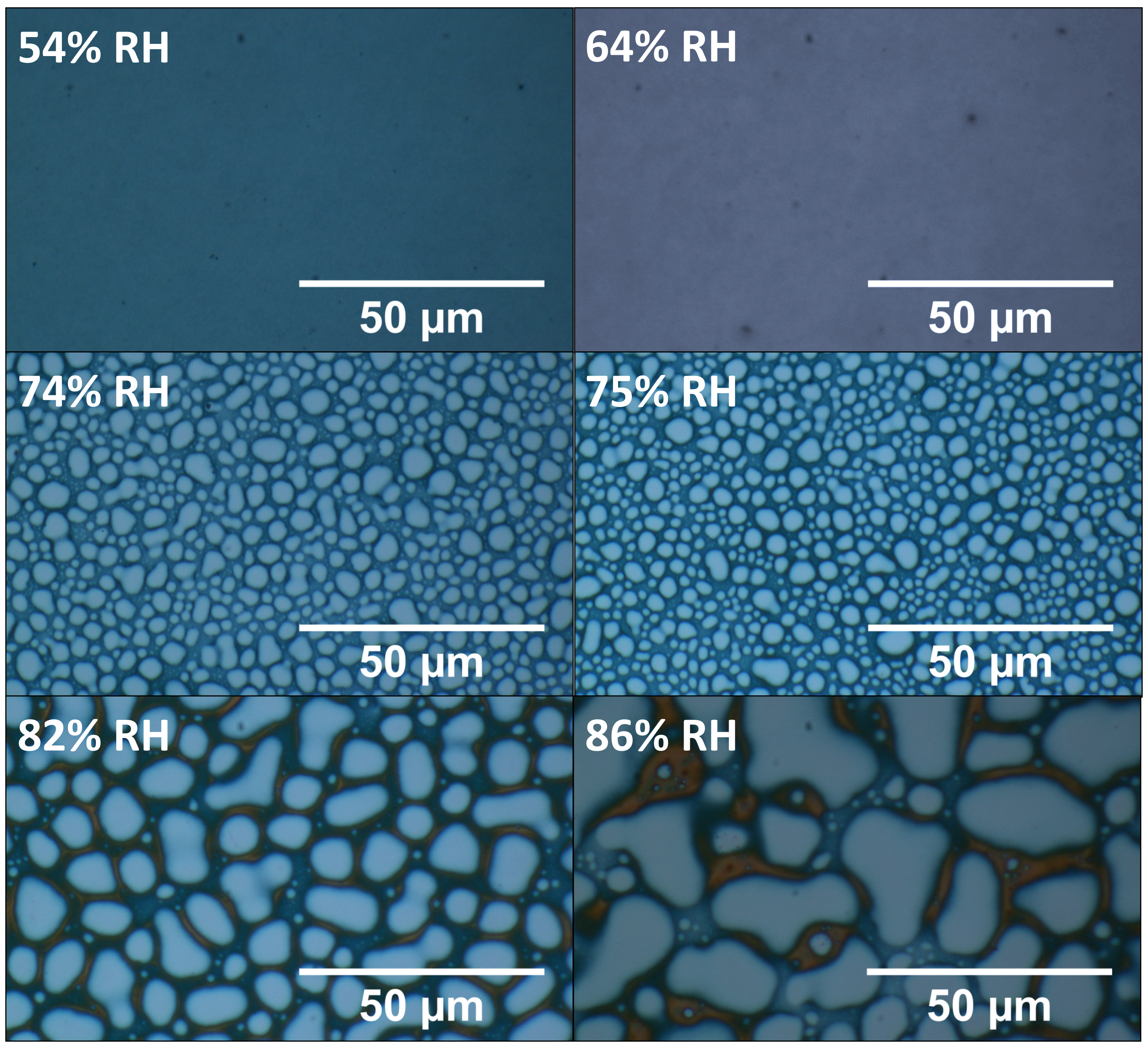


DHT11-type humidity/temperature sensor for Arduino module

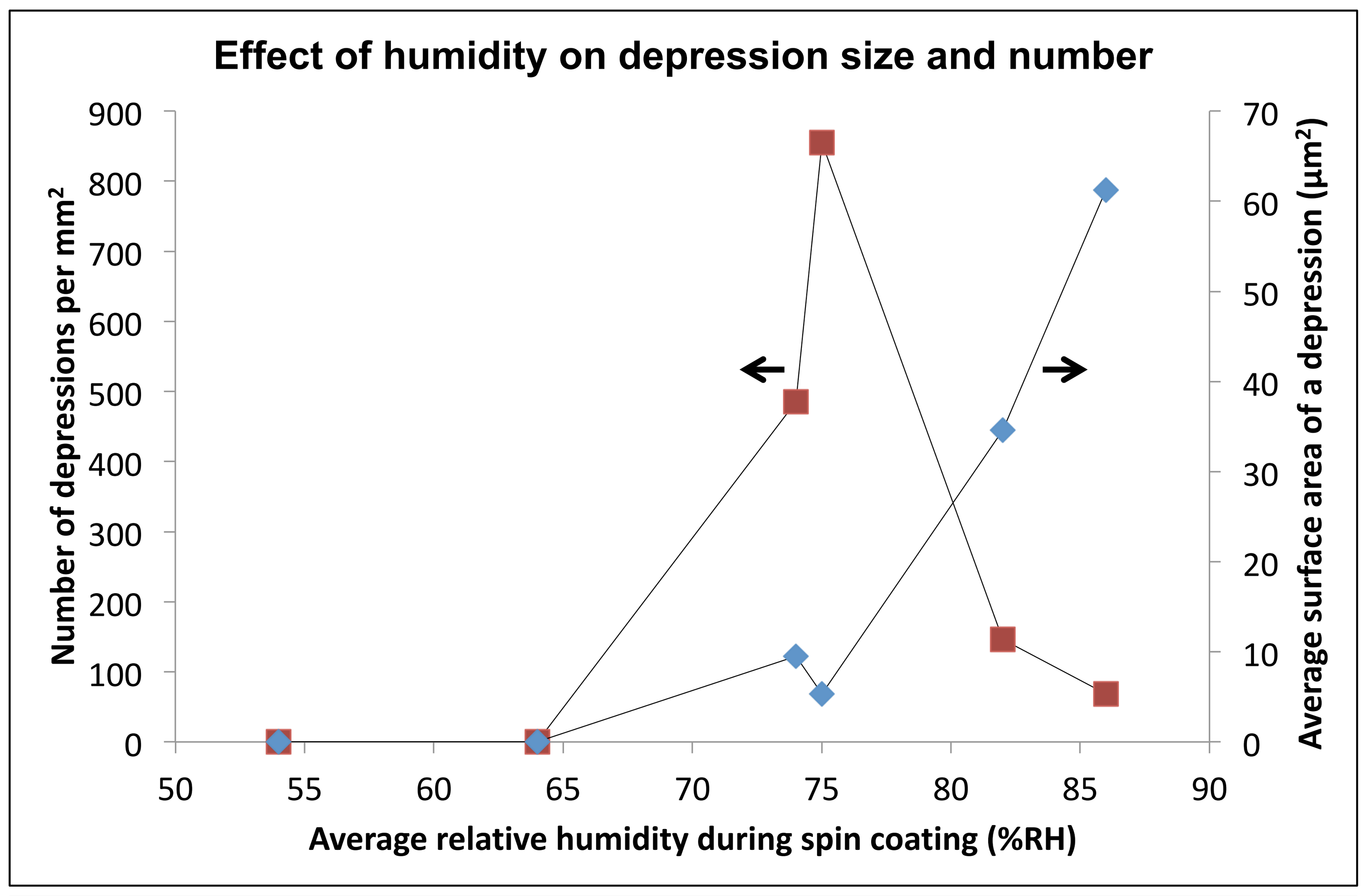
P3HT/p-xylene solution (left) and P3HT films spin coated onto UVO treated silicon wafers (right)

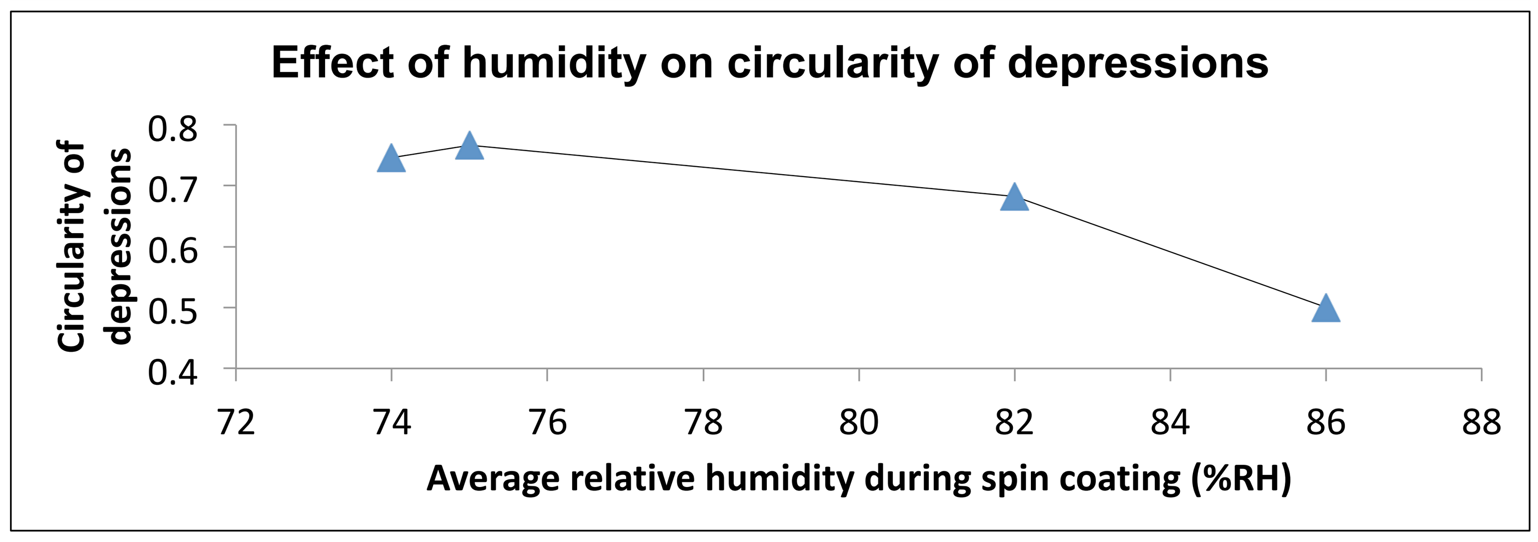
Results

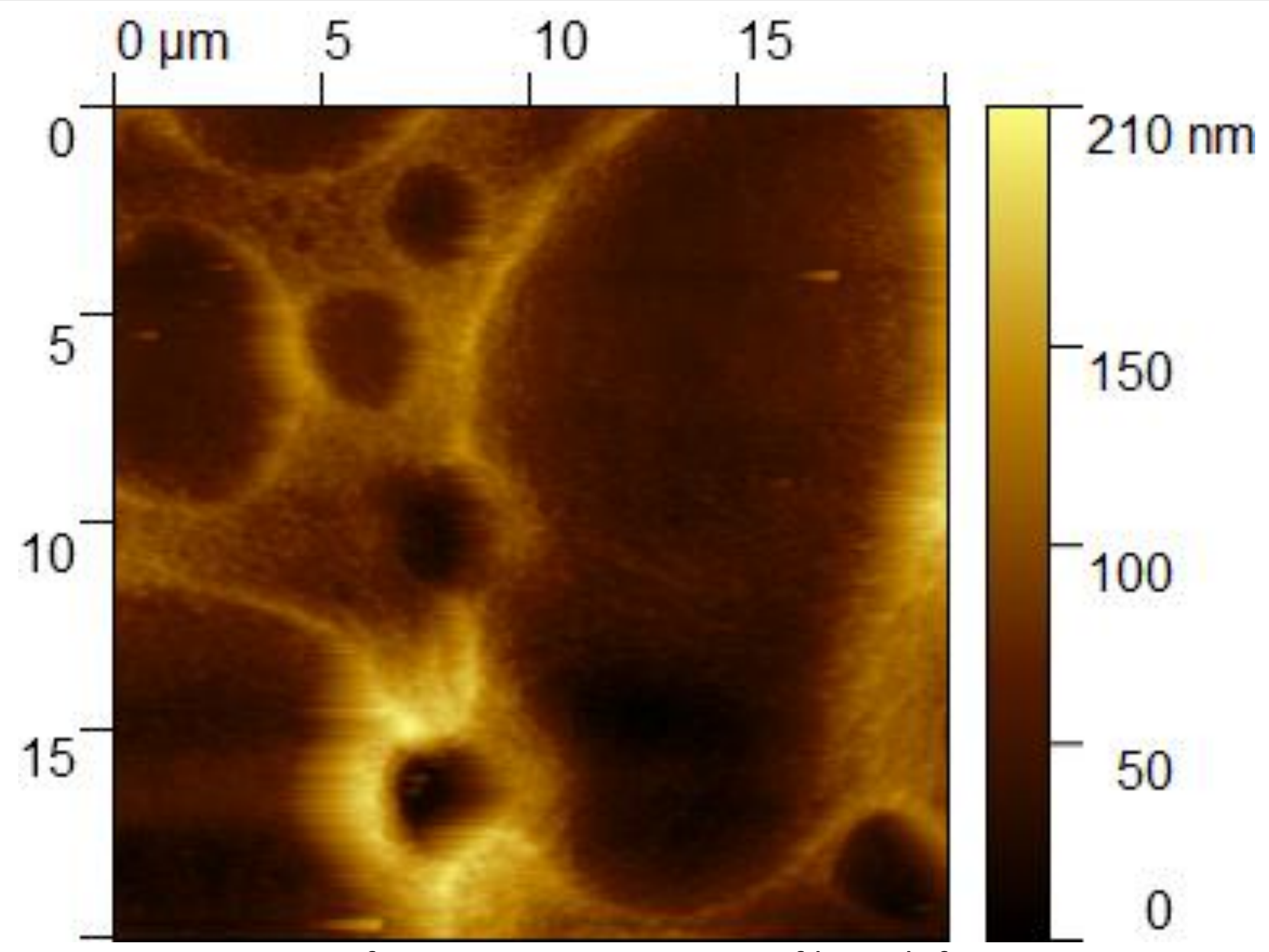
Optical microscopy shows an increase in depression size and decrease in depression circularity with increased relative humidity. Atomic force microscopy shows that depressions are extremely shallow.



Optical microscopy images showing changes in breath figures with average relative humidity







Atomic force microscopy image of breath figure

Conclusions

- Changing humidity allows there to be a tuneable surface structure in P3HT thin films
- There is a greater effect of capillary forces at a high relative humidity