UV-driven stimulated hydrophilicity of hydrophobic polysulfone

J. Reeks, B. Ishimwe, T. Haun, Y. Strzhemechny

Texas Christian University

Abstract

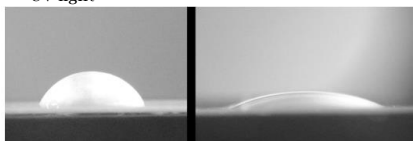
Polysulfone is a stable and strong semitransparent thermoplastic material that is applicable in many industries due to its resistance to low and high temperatures, as well as unique hydrophobic properties. Hydrophobic films are frequently used in waterproofing devices and to improve the efficiency of water vessels. It was recently discovered that polysulfone has a unique behavior as it changes from being hydrophobic to hydrophilic after exposure to a UV radiation. In order to elucidate the mechanisms behind this phenomenon we are performing surface photovoltage (SPV) studies on polysulfone thin films, which is done for the first time, to the best of our knowledge. Whereas SPV is sensitive to buried interfaces, SPV spectral features contain contributions not only from the polysulfone films, but from the silicon wafer and the silicon oxide layer beneath the polymer films. Thereby, to identify the signal germane to the polysulfone properly, we employ in our studies polysulfone films of varying and controllable thicknesses. To establish controllable methods for producing such films by spin coating, we use different concentrations of polysulfone in solutions with different spin rates. Film thickness is determined employing a thin film analyzer. From these thicknesses, trends are established relating film thickness to solution concentration and spin rate. SPV studies provide initial investigations into surface electronic transitions and mechanisms behind the hydrophobic 'flipping' of polysulfone.

Introduction

- Polysulfone is a naturally hydrophobic material
- Exposure to UV light causes it to flip from hydrophobic to hydrophilic
- This behavior can be applied in microfluidics
- Possible use as a 'water diode'
- Investigating the surface optoelectronic behavior through surface photovoltage (SPV) studies could reveal why polysulfone behaves this way

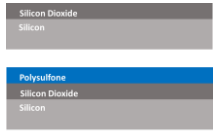
Hydrophobicity

- Hydrophobic flipping can be observed by the angle between the water droplet surface and polysulfone surface before and after exposure to UV light



Thin film interfaces affect SPV measurements

- To study the surface of polysulfone thin films of varying thicknesses must be produced
- This is due to the multiple interfaces that exist with thin films on substrates.
- This allows us to isolate polysulfone optoelectronic behavior from that of silicon and silicon dioxide layers

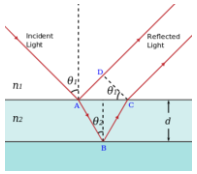


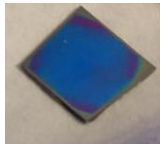
Producing thin films through spin coating

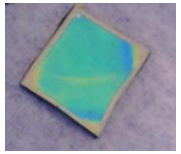
- We needed to control film thickness based on spin speed and concentration of polymer solution

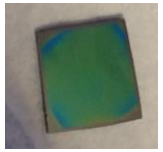
Film thickness can be estimated by thin film interference phenomenon

- Uniform thin films produce uniform color



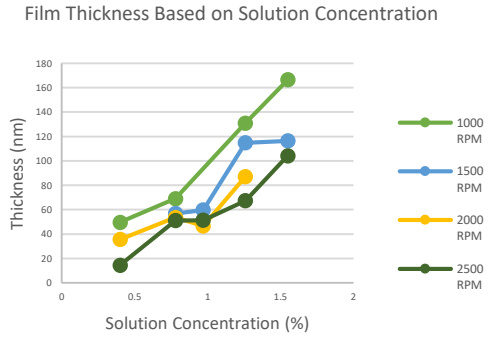


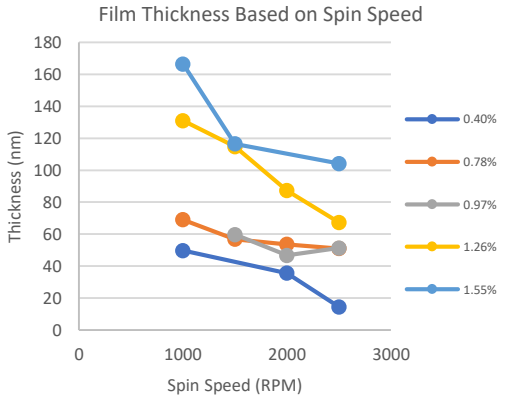




Film thickness measured by ellipsometry

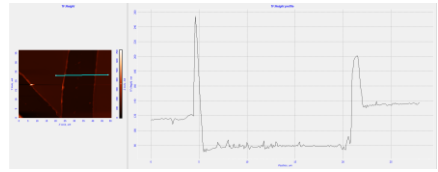
- Shows correlation between thin film recipe and film thickness





Film thickness measured by Atomic Force Microscope

- Can measure depth of a scratch in the film by AFM



Conclusions

- Inverse correlation of spin coat speed and film thickness
- Direct correleation of solution concentration and film thickness

Future Directions

- Investigate origin of hydrophobic flipping through SPV
- Study transient SPV of thin films based on exposure to UV and Visible light