Transfer-to-Excellence (TTE) Program

Center for Energy Efficient Electronics Science

Printed and Ultrathin Films of Peptoids

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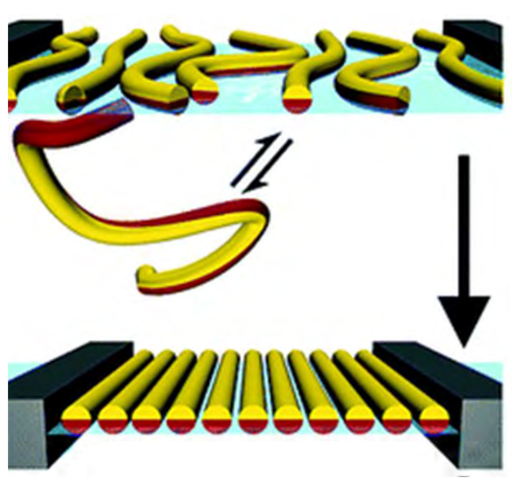
Abstract

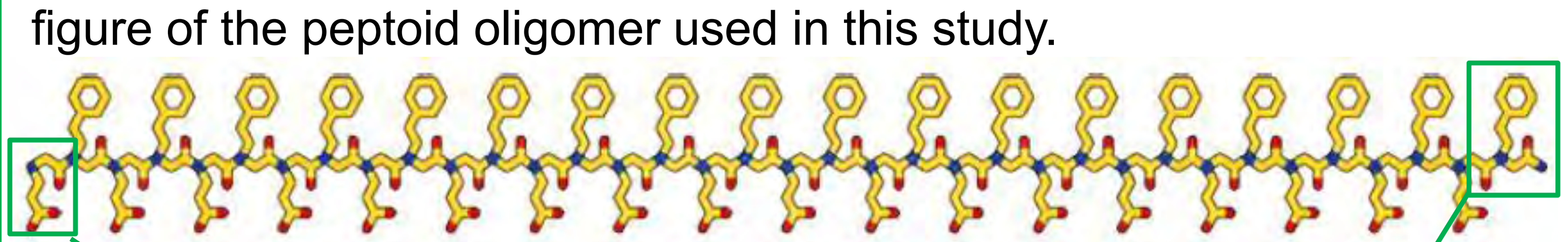
Peptoids are sequence-specific oligomers of N-substituted glycine with a similar structure to proteins. Their versatile structure and tunable characteristics make peptoids a fascinating material with many applications. In this work we studied the deposition of Langmuir-Blodgett (LB) films of an anionic peptoid. Film growth was primarily followed by surface pressure versus time curves, and then confirmed by AFM. A peptoid-based ink was prepared, characterized and tested in gravure printing. Both gravure and LB films are currently being tested in electrical measurements. We aim to assess the viability of applying such films in electronic devices as capacitors or transistors.

Introduction

Ultrathin and printed peptoid films are candidates for large-area electronic devices, and could lead to minimized fabrication costs [1]. Also, peptoids can form 2-D nanosheets with plenty of potential applications [2].



The study of material's electrical properties is the first step at fabricating electronic devices, and ultrathin films are extensively used in order to get low-voltage operating devices. Below is a figure of the peptoid oligomer used in this study.



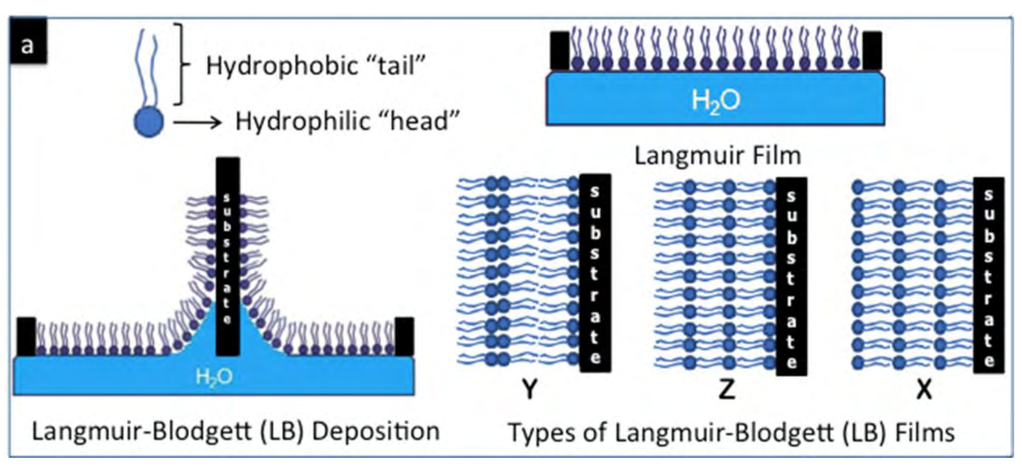
Model of PC, $(N_{pe}\text{-}N_{ce})_{18}$

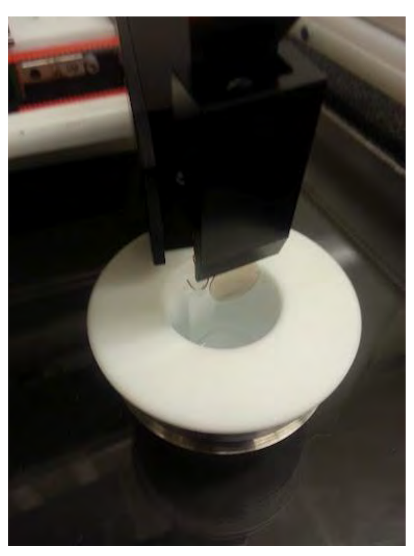
N_{ce}
N-(2-carboxyethyl) glycine

N_{pe}
N-(2-phenylethyl) glycine

Methods

- ❑ Nanostructured thin films: Langmuir-Blodgett

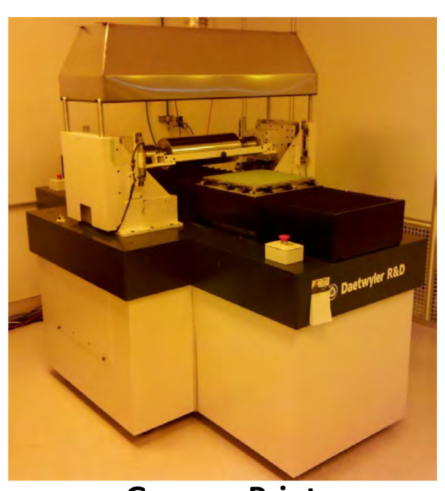




Langmuir-Blodgett

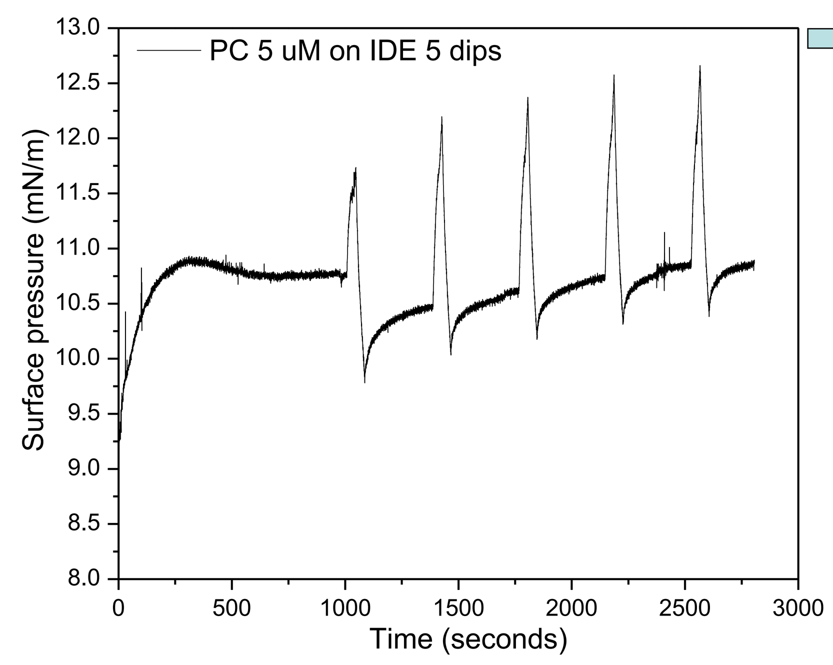
- PC: 5 uM solution
- PC+Co: PC 20 uM + 1 mM Co^{2+} (pH 7.3)

- ❑ Atomic Force Microscopy (NanoscopeIII - Veeco)
- ❑ Ink Characterization: Viscosity (Rheometer – Brookfield)
- ❑ Surface Characterization: Contact Angle (Ramé-Hart)
- ❑ Printed Films: Gravure (Daetwyler R&D)
- ❑ Ink-jet printing: Dimatix DMP2800 (Fujifilm)

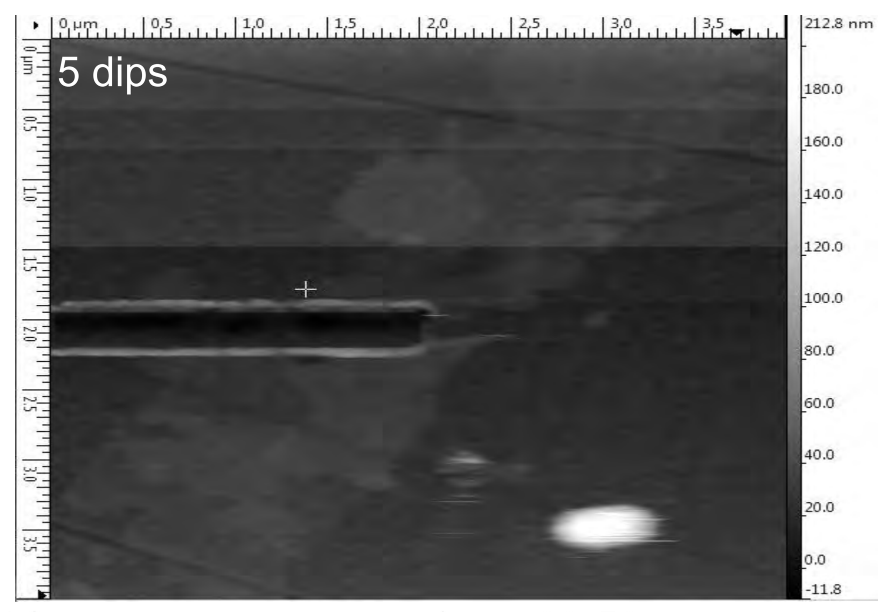


Gravure Printer

Results



π versus time curve showing materials deposition
⇒ similar results for PC + Co 10 dips



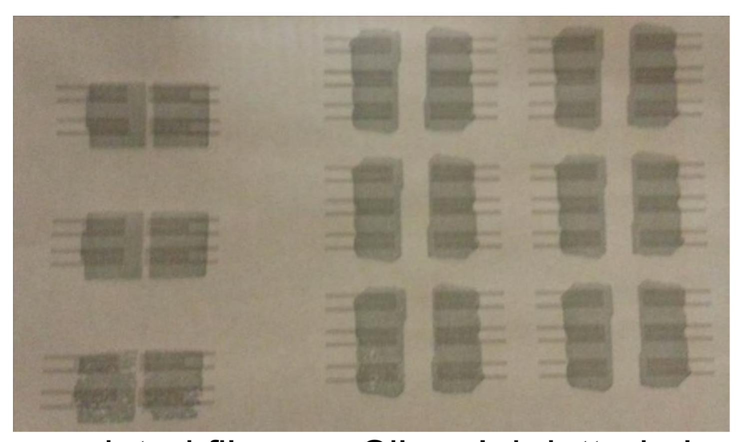
PC on gold: continuous film - 20-50 nm thickness

Contact Angle

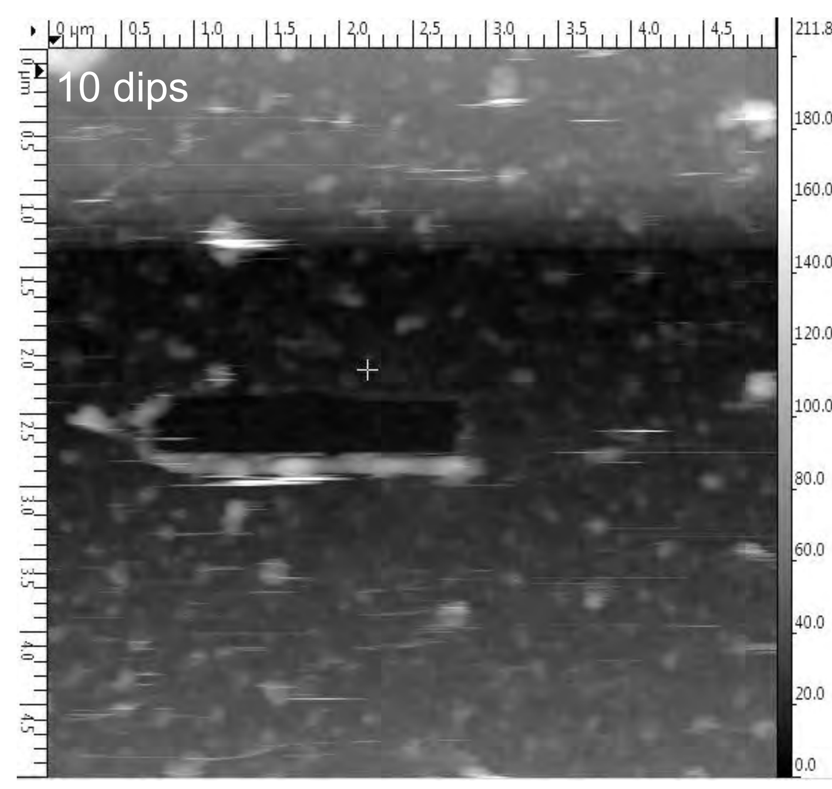
Substrate	Treatment	θ (°)*	Deviation
Glass	-	28.4	1.9
Glass	Plasma	11.1	2.0
Au-IDE	-	73.7	3.2

Ink Viscosity

12 uM PC + PEG additive = ~12 cP



Gravure printed films on Silver Ink-jetted electrodes



PC + Co on gold: continuous film - 8 nm thickness

Discussion

Langmuir-Blodgett films showing continuous substrate coverage were deposited for both PC and PC containing cobalt, and film thicknesses were lower than 50 nm for 5 to 10 dips of both. This continuous film deposition is integral to pursuit of ultra-thin and printed peptoid electronic devices.

Plasma treatment was showed to be vital for substrate hydrophilicity, and inks with viscosity in the ideal range for gravure printing were attained by using PEG as additive. Through detailed pattern engineering in the inkjet printer software, silver electrodes were positioned on substrates to match the output pattern from gravure printer. This allows a more efficient and faster fabrication of devices.

Conclusions and Perspectives

Basically all the steps for printed device fabrication were covered here, including ink preparation, surface characterization, and inkjet and gravure training. Langmuir-Blodgett and gravure printed films of peptoids are currently being tested in electrical characterization for possible application in transistors.

References

[1] Sanii, B. et al, *Journal of the American Chemical Society 133* (2011) 20808-20815.

[2] Nam, K.T. et al, *Nature Materials* 9 (2010) 454-460.

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