Interdiffusion in Thin Polymer Films

Group3
Student presentation

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Outline

- Task
- Neutron Reflectivity
- Results
- Discussion
- Acknowledgement
Task

- Study inter-diffusion between (525 KDa) PS and d-PS thin films as a function of film thickness.
- To determine the effect of thickness (confinement) on interdiffusion.
- To learn properly performing a reflectivity measurement for polymer thin films and have fun.

Samples

h-PS

d-PS

1Rg

1Rg

1Rg

2Rg

1Rg

4Rg
Sample Preparation

- **1st layer** Spin coating
- **2nd layer** Floating
- Dispense
- Ramp-up speeding
- Constant drying

Water
Data Regression and Fitting
Roughness Shows Interdiffusion

Scattering Length Density Profile

Distance from Top Surface (Å)

SLD (Å²)

2Rg AC
2Rg 5m
2Rg 20m
2Rg 100m
2Rg 50m

TREATED
SILICO

NCNR Summer School
28-Jun-12
Crunch time

\[ D = \sigma^2 / 2t \]

\[
\begin{array}{|c|c|c|c|}
\hline
 & 1Rg/1Rg & 1Rg/2Rg & 1Rg/4Rg \\
(Å) & (Å) & (Å) & \\
\hline
0 min & 3.7 ± 1.9 & 5.5 ± 1.5 & 5.4 ± 0.2 \\
5 min & 26.8 ± 0.5 & 33.0 ± 1.4 & 25.8 ± 0.9 \\
20 min & 28.1 ± 2.6 & 41.7 ± 1.3 & 41.8 ± 1.0 \\
50 min & 47.6 ± 2.6 & 50.7 ± 1.4 & 50.8 ± 1.5 \\
100 min & 59.1 ± 9.8 & 67.8 ± 6.5 & 60.0 ± 2.7 \\
\hline
\end{array}
\]

\[ y = 0.5876x + 13.15 \]

\[ R^2 = 0.9372 \]

\[ y = 0.5736x + 21.578 \]

\[ R^2 = 0.9849 \]

\[ D = \sigma^2 / 2t \]

\[ 1Rg/1Rg \]

\[ 1Rg/2Rg \]

\[ 1Rg/4Rg \]

\[ \Delta \sigma \] (Angstrom)

\[ t(s) \]

\[ 1Rg \]

\[ 2Rg \]

\[ 4Rg \]

\[ D (cm^2/s) \]

\[ 1.68 \times 10^{-17} \]

\[ 1.68 \times 10^{-17} \]

\[ 1.55 \times 10^{-17} \]

0 min | 3.7 ± 1.9 | 5.5 ± 1.5 | 5.4 ± 0.2
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\[ D (cm^2/s) \]

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\[ 1.55 \times 10^{-17} \]
Conclusion

- Roughness of the interface between PS and d-PS increases with annealing time.
- Dynamics of polymer chains under confinement can be studied through neutron reflectometry.
- No significant change in diffusion coefficients observed under different confinement conditions.
- More time points are necessary to produce more reliable fitting.
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Questions?

Bulent will answer