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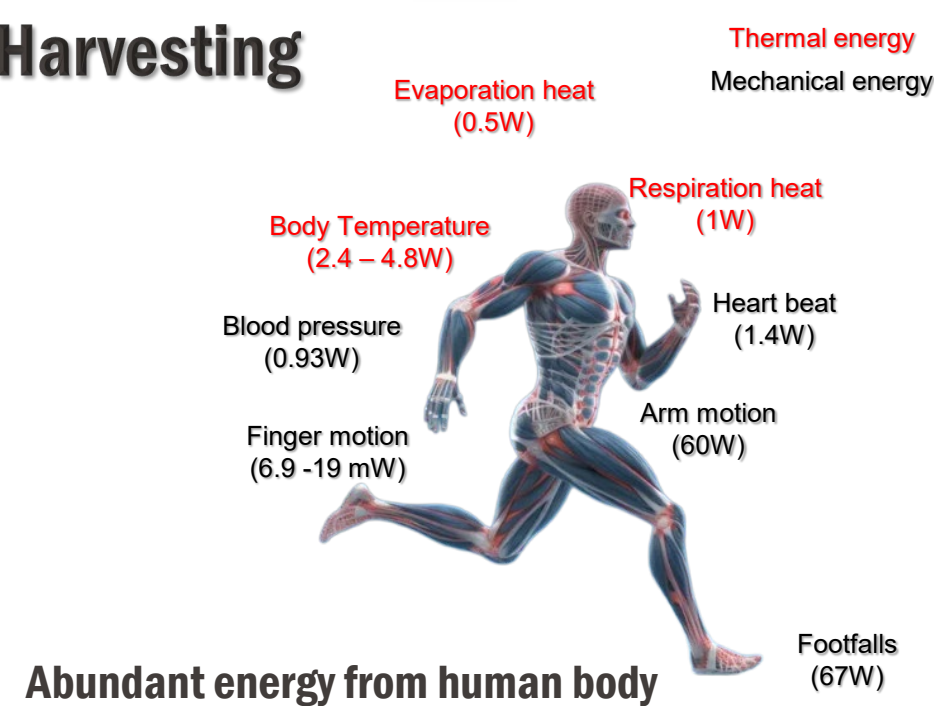
POLYMER LABORATORY  
LAUSANNE POLYMÈRES

## Introduction

- Tracking the workout
- Keeping client connected
- Monitoring daily stats
- ...



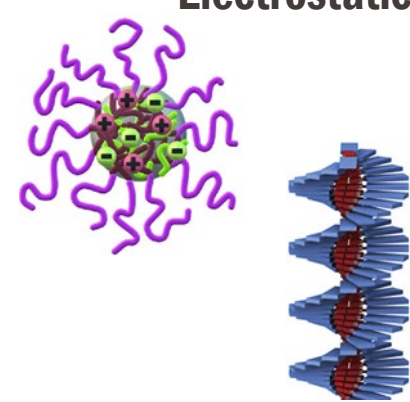
### Energy Harvesting



### Polar Polymer Film

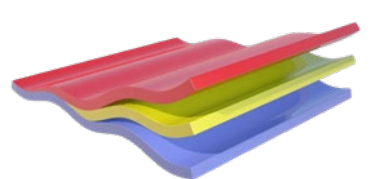
#### Electrostatic self-assembly

Science, 1997, 276, 384  
Angewandte Chemie, 2000, 112, 8  
Nature 1999, 398, 137  
Chem 2017, 3, 764  
Polymers 2024, 16, 2097



Polypeptides

#### Conformal coating

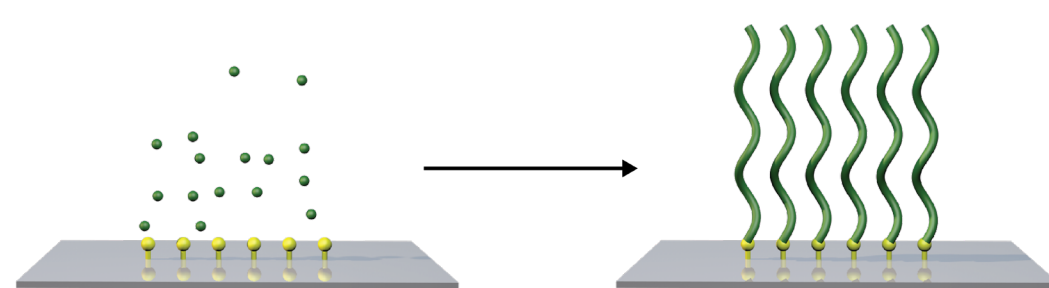


- Complex building blocks
- Weak, non-covalent interactions
- Stability
- Difficult to control chemical composition

- Solution processing
- Melt-based processing

### Polymer Brush

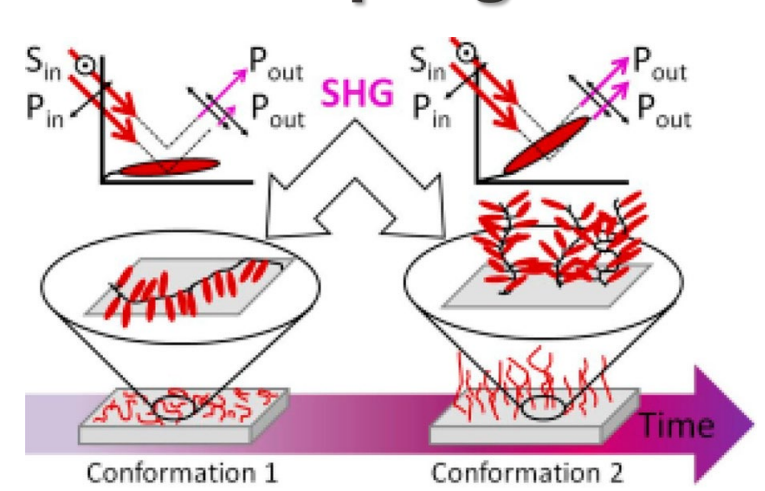
### Side Group Alignment



- Chemically anchored on the surface
- High grafting density
- Stretched polymer chain

Chemical Reviews, 2009, 109, 5437-5527  
Chemical Reviews, 2017, 117, 1105-1318.

- Polymer brush is an effective way to modify surface properties.



Characterized by second harmonic generation

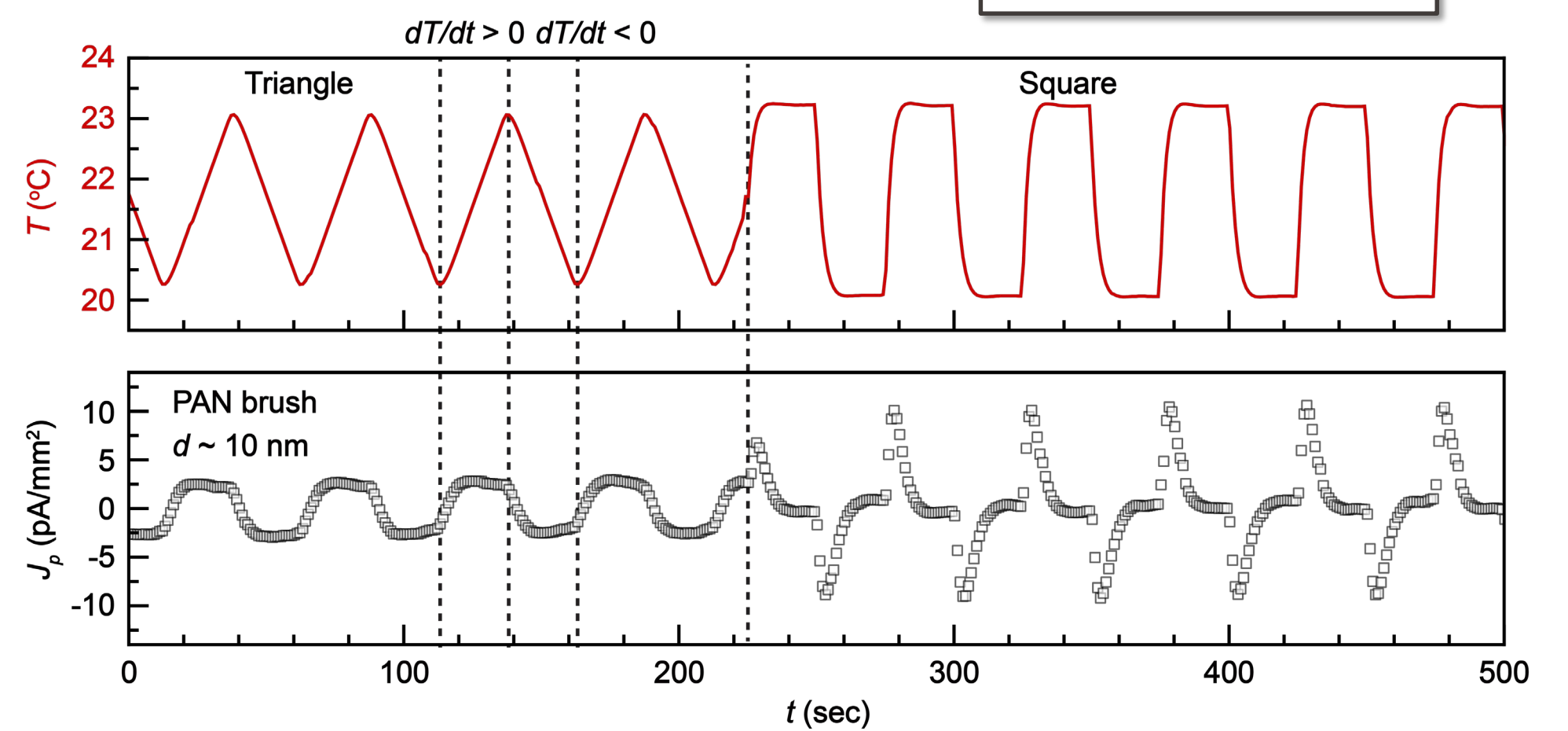
Langmuir, 2017, 33, 4157-4163

- The orientation of dipolar liquid crystalline side chains in polymer brushes evolves progressively with brush thickness

## Pyro- and Piezoelectric Measurement

### Dynamic Pyroelectric Measurement

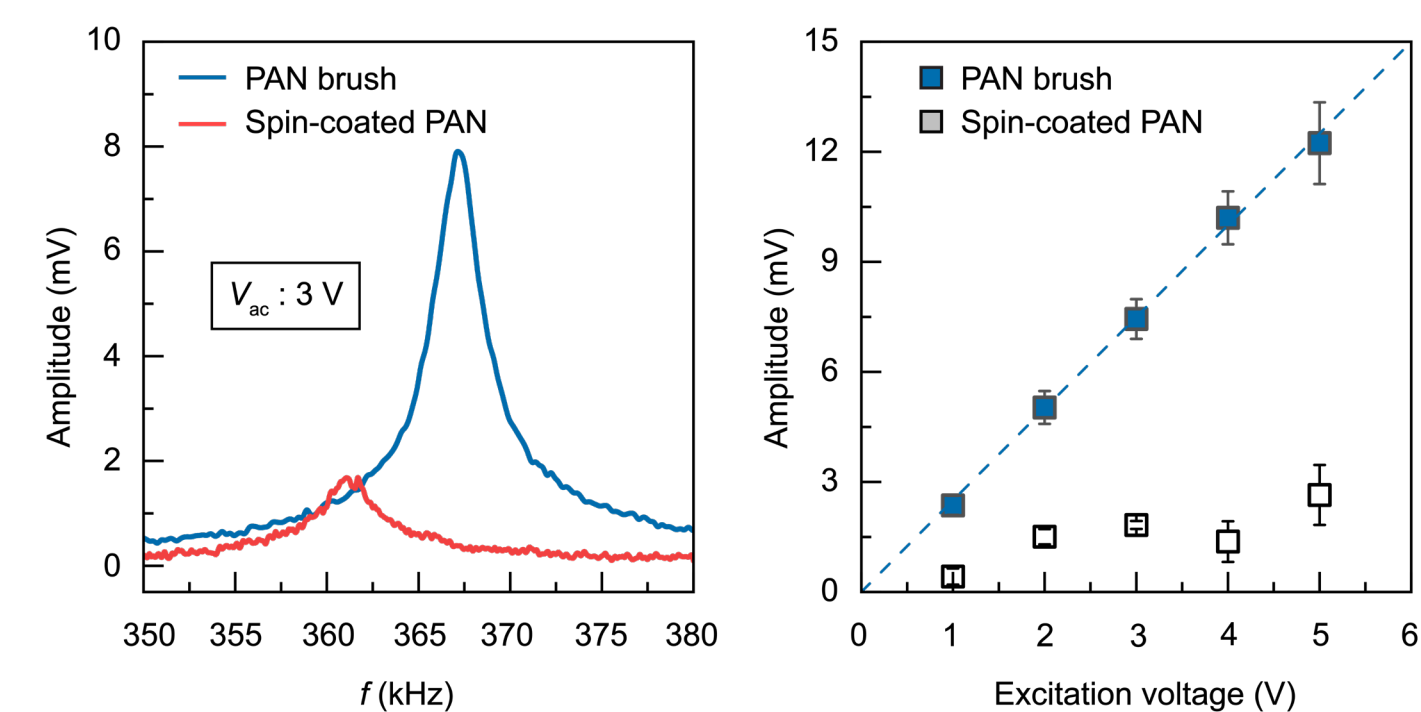
$$I_{pyro} = p \times \frac{dT}{dt} \times A$$



- The pyroelectric coefficient is comparable with commercial poled PVDF!

### Piezoelectric Force Microscope (PFM)

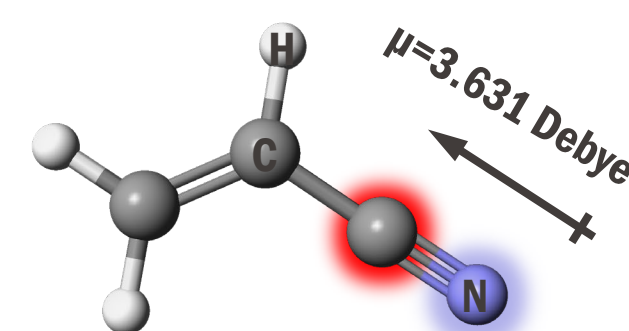
Science, 2024, 383, 1492-1498



- PFM showed that PAN in the brush architecture has much higher piezoelectricity than the spin-coated form, suggesting the structure promotes macroscopic polarization.

## Model System

### Polar Side Group



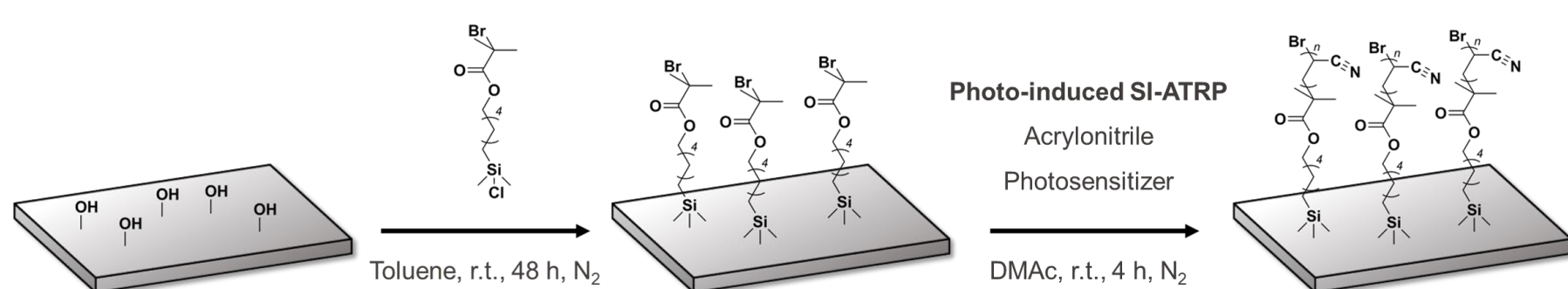
- Large dipole moment
- Suitable for SIP
- Hydrophobic polymer

\*Calculated by



### Preparation of Polyacrylonitrile Brush

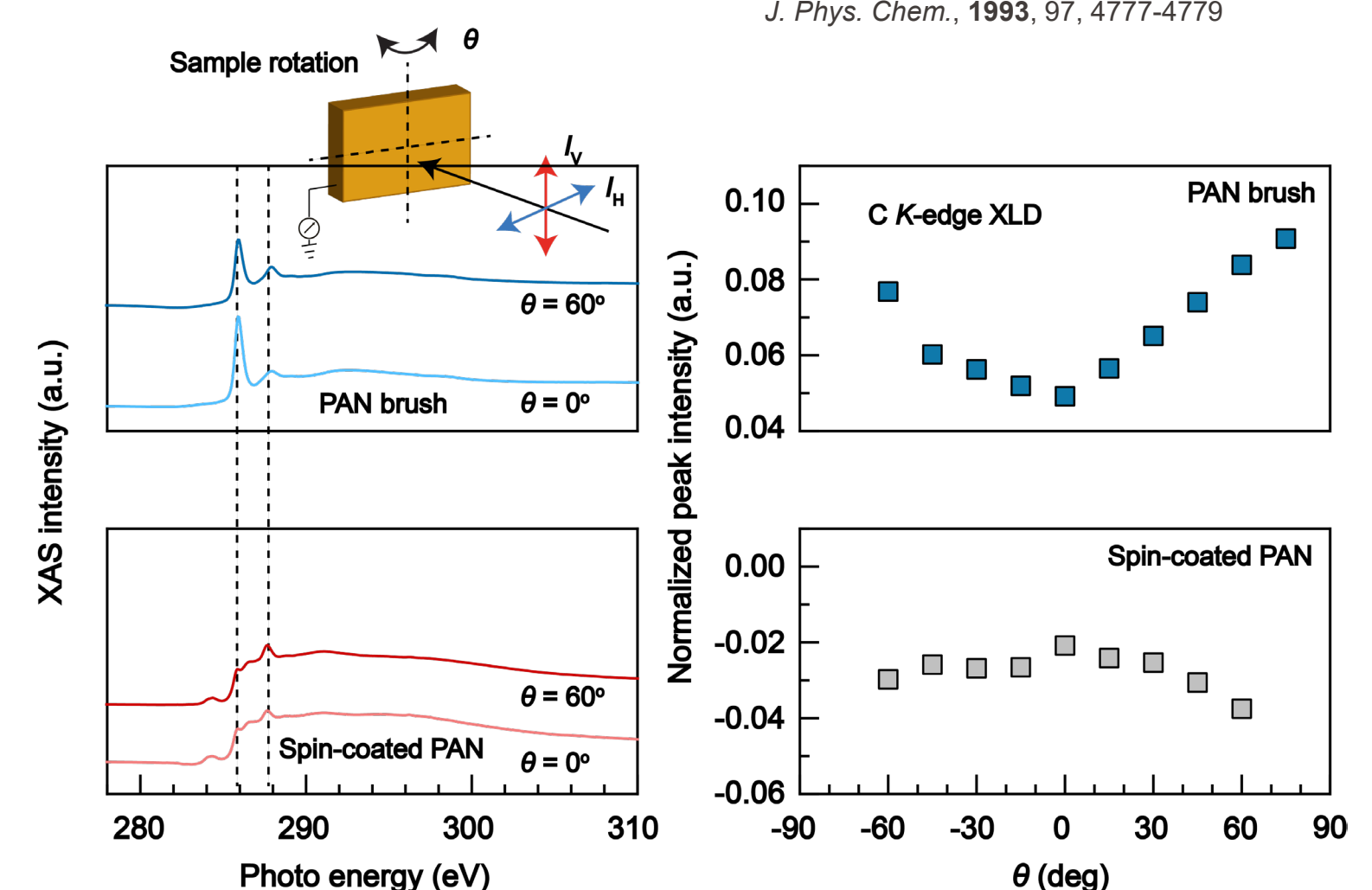
Angew. Chem. Int. Ed., 2018, 57, 13433



- Photo-induced metal-free surface-initiated polymerization

## Synchrotron Radiation

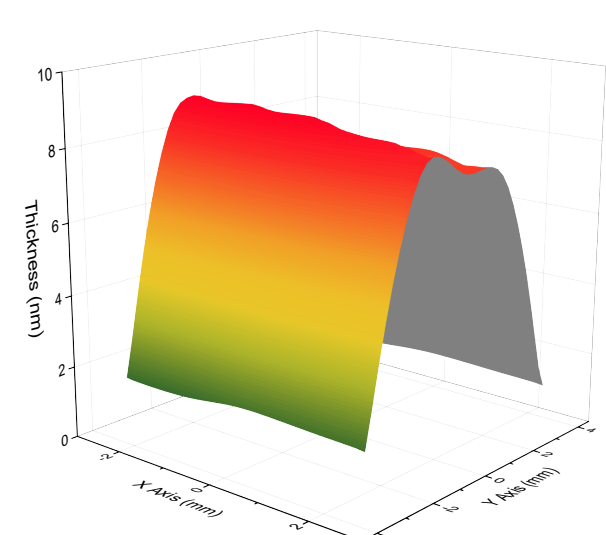
J. Phys. Chem., 1993, 97, 4777-4779



- NEXAFS revealed the spatial anisotropy in the distribution of -CN groups.

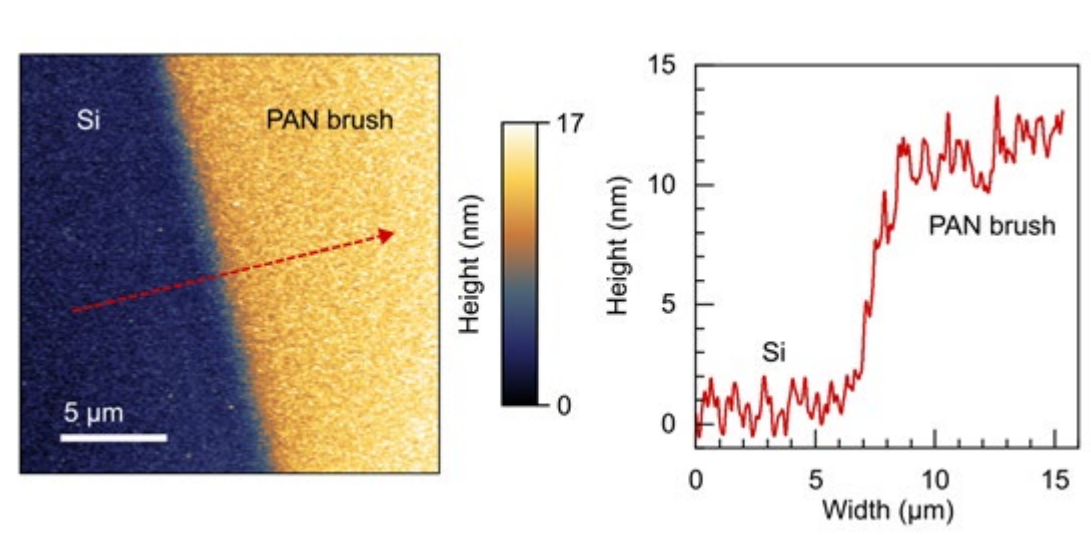
## Polymer Brush Thickness

### Ellipsometry



- Ellipsometry confirmed the film thickness around 10 nm

### Atomic Force Microscope (AFM)



- AFM verified the uniformity of the thin PAN brush film and was consistent with Ellipsometry data.

## Summary

Our study shows:

- The polymer brush structure can reorient polar side groups.
- This further induces spontaneous macroscopic polarization.
- Pyro- and Piezoelectricity emerge without post-treatment.

## Acknowledgements

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