Hydrogen-Bonded Polyaramid Brush Growth on Silica Surfaces

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Abstract

Polyaramid brushes are polymers that are grown covalently from a surface yielding a durable coating similar to Kevlar® but at a fraction of the size. Polymers brushes were grown on silica wafers using chain growth condensation and then cleaved to display hydrogen bonding between the brushes which created a self-healing, durable structure. Three side chains – 4-tert-butyloxybenzyl (NOB), 4-hydroxybenzyl (HOB), and tertbutyl – were used in polymer brush growth to aid in solubility and are removed from the brushes using trifluoro acetic acid or copper trflate to give the amide proton which allows for hydrogen bonding. Kinetic and solubility experiments were used to understand the effect of these functional side chains on growth rate, molecular weight, and molecular weight distribution. The tert butyl side chain showed the fastest kinetic rate for the phenol monomers at a $k_r$ of 10.4 ± 1.1, but currently the smallest brush growth compared to brush growth of NOB and HOB. These and continued kinetic tests will further determine the best kinetic rate for maximum brush growth for the most efficient durable polymer brushes.

Background

Polymer brushes are polymer chains attached covalently to a surface. Aromatic rigid rod ideally creates more thermally durable brushes and more brush interaction. Overarching Project Goal: To create durable surface coatings using polyaramid brushes.

Protecting the Polymer

- Increase solubility of brush by adding a more soluble side chain
- Chain can be removed to allow hydrogen bonding
- Side chains can effect polymerization rate and solubility, changing the performance of the reaction

Growth of Polymer Brushes

- Growth effected by: Temperature, Monomer and Solubility

Addressing the Kinetics

- Previous kinetic data for different monomer leaving groups was conducted using an otyl side chain

Conclusion

- The different side chains effects the solubility and kinetic rate of polymer brushes and change the polymerization rate of the phenol monomer.
- All side groups have had some brush growth on both silica wafers and Stöber silica and have been successfully cleaved to demonstrate the hydrogen bonding necessary for durable surface coatings.
- Solubility tests - though currently inconclusive - show potential for understanding different brush growth lengths.

Future Directions

- Further kinetic and solubility tests to determine the best monomer for brush growth
- Adjust methods to increase brush growth on silica wafers by changing reaction conditions and monomer groups
- Conduct durability tests to verify limitations to new surface coatings.

References


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