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Polyacrylamide Chemistry Provides Pathway to Novel Polymers (20180205, Dr. Marc Hillmyer)

Technology ID
20180205

Category
Engineering & Physical Sciences/Chemicals
Engineering & Physical Sciences/Materials

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Activated Polyacrylamide Synthesized Using Electronically-Activated Amides

A new method produces an acrylamide monomer that allows chemical modification of its corresponding polymer under mild conditions. Electronic activation of acrylamide via introduction of tert-butyloxycarbamate (Boc) groups followed by radical polymerization enables the synthesis of a new class of activated polyacrylamide. Transamidation of poly(di-Boc acrylamide) (PDBAm) may proceed under mild conditions, and the resulting polymers can be purified via simple heating, resulting in high yields with nearly complete conversion of the starting polymer to the new polyacrylamide. In each case, polymers with new properties (e.g. glass transition temperature or chemical functionality) are obtained from the parent PDBAm. The novel use of electronically-activated amides (i.e. acyl substituted primary amides) in this technology allows synthesis of polymers otherwise unobtainable by direct polymerization and prepares a diverse array of macromolecular structures.

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Transamidation of Pdbam at Low Temperature with Higher Yields and Simplified Purification

Preparing polyacrylamides via post-polymerization modification is currently accomplished using polyacrylates containing activated esters, which react with amines to yield desired polyacrylamides. Current chemical methods for derivatizing polyacrylamides require harsh reaction conditions, limiting their use and application, and transamidation modification requires high temperatures in neat amine. To date, there are no existing reports of polyacrylamides capable of facile transformation of one amide into another, nor of using electronically-activated amides (e.g., DBAm) in a polymeric context. This new technology synthesizes a new class of activated polyacrylamide under mild conditions. The functionalization of the polyacrylamide through transamidation may occur at room temperature with stoichiometric quantities of the desired primary amine. The mild conditions for transamidation provide higher yields (compared to using activated ester-containing polymers) and simplifies purification (byproducts can be removed via heat). Additionally, PDBAm is hydrolytically stable, which is not always the case with other polymers containing acid chlorides or activated esters that are currently employed for post-polymerization modifications.

BENEFITS AND FEATURES:

- Enables expansion of polymer compositions made with acrylamide
- New class of activated polyacrylamide
- Electronically-activated amides
- Nearly complete conversion of starting polymer to new polyacrylamide
- Synthesizes polymers otherwise unobtainable by direct polymerization
- Enables diverse array of macromolecular structures
- Milder reaction conditions
- Higher yield
- Simplified purification

APPLICATIONS:

- Chemical / polymer industry
- Polyacrylamides
- Hydrogel materials, block copolymers, tunable nanostructures and surface modification
- Functionalized polyacrylamides (personal care products, water treatment, drug delivery)
- Hydrogels: eye care products, wound dressings, drug delivery vehicles, tissue engineering scaffolds, cosmetics and hygiene products, environmental purification and wastewater treatment
- Block copolymers: Responsive and functionalizable nanocarriers for biomedical applications, thermoplastic elastomers, soft lithography, directed self-assembly and porous structures, functionalizable surface coatings and adhesives
- On-demand preparation of gels
- Patterning of PDBAm-coated surfaces with amines
- Nanostructured block polymers with engineered domain size and/or shape
- Modification of bulk polymer properties after synthesis

Phase of Development - Proof of Concept

Researchers

Marc Hillmyer, PhD

Professor, Department of Chemistry, College of Science and Engineering

External Link (chem.umn.edu)

Publications

Activated Polyacrylamides as Versatile Substrates for Postpolymerization Modification

ACS Macro Letters, 2018, 7 (1), pp 122–126

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