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Commentary

The Synthesis and Potential Applications of Oligomers

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DESCRIPTION

Oligomers are low molecular weight polymers containing few repeated units whose physical properties are altogether dependent upon the length of the chain. Oligomers are essentially intermediates of the polymerization reaction that find wide, direct applications in material science. Oligomers can be arranged into addition oligomers and condensation oligomers, based on the structure of the repeating unit. The Step growth polymerization occurs in one step at a time through a series of simple organic reactions, for example, carbonyl addition-elimination reaction utilized for the preparation of polyesters and polyamides, or expansion to various bonds, utilized for the preparation of polyurethanes and polyalkylene sulfides. Depolymerization of high polymers and chemical adjustment of oligomeric species are extra routes for the synthesis of oligomers.

Oligomers are consisting of repeating subunits that occupy an exceptional area of chemical space between discrete small molecules and higher molecular weight polymers. While the transition from an oligomer to a polymer isn't generally clear according to a simply structural point of view, the IUPAC definition depicts an oligomer as a molecule that "has properties which truly do differ significantly with the removal of one or a couple of the units". This definition features a vital driver for oligomer research, especially in microscopically characterized cases that have been a focus of materials researchers [1-3]. The compound space between classical organic and macromolecular chemistry we term "macro-organic chemistry" as it uses the advantages of the advanced chemistry of both small molecules and polymers. This is exemplified by the significance of oligomer sequence as well as length in biological systems with classical examples being the connection of oligosaccharides with lectins, the capacity of siRNA to silence genes or the deficiency of enzyme activity after a point mutation. While the role of discrete oligomeric molecules keeps on being an increasingly active area of exploration in (chemical) biology, the capability of abiotic synthetic oligomers to generate rising thermal, mechanical, and self-assembly properties is significant.

According to a historical perspective, the synthesis of biologically important oligomers brought organic and biochemists together in their efforts to push the frontiers on what is technically possible [4]. Modern molecular biology wouldn't exist without the historic synthesis of discrete and sequence-controlled oligopeptides, oligonucleotides, and oligosaccharides. The synthetic chemists combined advanced organic techniques for the combination of complex liquid crystals, dendritic macromolecules, foldamers, and a large variety of π-formed oligomers and polymers.

The current survey features the different chemical approaches to deal with oligomeric materials with an emphasis on materials properties that are modulated by a change in oligomer length, succession, or stereochemistry. Furthermore, given the broadness of chemical space that can be considered "oligomeric," this survey will emphasize abiotic oligomeric species that have been recently produced for materials science applications and give experiences into structure-property relationships.

The synthetic approaches used to plan oligomers have taken inspiration from both macromolecular and small molecule organic chemistry. At one extreme, the synthetic polymer chemistry prompts structures with dispersion of molecular weights or Degrees of Polymerization (DP) and despite progress in controlled and living polymerization, group properties can be dominated by either low atomic weight or high atomic weight fractions [5]. Because of the possibility of using accuracy oligomeric species that have emergent material properties, a variety of synthetic methodologies have been created based on oligomer structure, size, and scale necessities. As not a single solution for this issue exists, the technique utilized changes with the desired goal, whether to explore new chemical space for an ideal sequence or for targeted and scalable materials production. These approaches to deal with exact oligomers can be isolated into two general methodologies including either iterative, multi-step syntheses or the partition of dispersed oligomeric mixtures.

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