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Application of Boron-Based Polymers

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Abstract- **Boron based polymers play a vital role in inorganic polymers due to their conventional synthesis route. Various synthetic route i.e. Sonogashira−Hagihara coupling, hydroboration polymerization, alkene insertion, grafting, and polycondensation. This review comprises of its various synthetic approach and advanced applicability and potential use in electronic, industrial and medical field.**

Keywords: Boron based polymer, synthesis and application

I. INTRODUCTION

Organo boron based polymers were synthesized using monomers like borazine, phosphine borane, carborane,etc. other types such as borane cluster containing polymers, its block copolymers (telechelic polymer) has been synthesized and characterized for its chemical and physical properties[1-2].Due to flexibility, good processibilty and excellent sustainability at higher temperatures, the dielectric boron nitride based polymers find its applications in materials like ceramic. It allows researchers to develop next-generation energy storage material in the field of aerospace power electronics, sensing, catalysis, biomedical applications, underground oil and gas exploration purpose, also other electronic gadgets like photovoltaic devices, LED (light emitting diodes), effect transistors and laser oscillators [4 3].

Polymer-based on boron has a lack of typical specific preparation method. Therefore, it has become essential to introduce innovative, rational, selective, high-yield reaction pathways. Different pathways have been reported for the synthesis of various boron based polymers [5] Formation of certain compounds like halopolyboranes which act as important precursor materials for the development of functionalized polyboranes and carboranes. Decaborane alkyne-hydroboration reactions accelerated via a metal catalyst provides higher yield and efficient route to mono- and dialkenyldecaboranes. Alkenylborane transformations to important molecular, polymeric and solid-state materials supported and accelerated through the catalyst, i.e., with help of transition metal or an ionic liquid. Various methods like selective synthesis and functionalization method of metal latricarbadecaboranyl complexes are developed for biomedical and electronic application.

Polyborates are a class of inorganic compound (salt) containing boron atoms within their anionic moieties. These boron atoms are bound solely to oxygen and can adopt either trigonal-planar or tetrahedral connectivity. The cations of these salts can be ‘naked’ metals (e.g. Na^+), organic, or transition-metal complexes and furthermore, polyborates may also be anhydrous or hydrated. Consequentially, polyborates show immense solid-state structural diversity with ‘hydrogen-bonded insular systems’ and ‘supramolecular polymeric systems’ well represented within the class. Polyborates have unique properties and a few (e.g. $Na_2[B_4O_5(OH)_4]{\cdot}3H_2O$ = $Na_2B_4O_7{\cdot}5H_2O$, ‘borax pentahydrate’) have been used in the production of a wide variety of bulk products such as insulation fiberglass, specialty glasses, enamels and glazes, fertilizers, biocides, fire retardants, detergents etc. So far, distinct borates

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containing f- block (rare earth) metal, d-block (transition) metals and s-block (alkaline and alkaline earth) metals as well as nonmetal cations, have been synthesized by different routes such as hydrothermal synthesis, solid-state reactions, and the boric acid flux technique. Polyborates crystals isolated from cationic aqueous solution till $B(OH)_3$ role as DCL (dynamic combinatorial library) of polyborate anions [2-7].Three-dimensional structure of penta borate anion $[B_5O_6(OH)_4]^-$ has a facile capacity to accommodate different size non-metal unicharge cations [8,9].

APPLICATION OF SYNTHESIZED BORON BASED POLYMER

These polymer materials have a number of important properties which make it useful for a wide range of application in the following area:

Basic Generalized Application of Boron Based Polymers
Medical agents, Burn rate modifiers, catalyst
High-temperature polymers
Extractants for nuclear waste
Ceramic precursors
Gas storage: chemical hydrogen-storage systems
Weakly coordinating anions

The various research works on such synthesized polymers is summarized as follows:

Alumino-poly borates were synthesized found to have non linear optical (NLO) second-harmonic generation properties by Wang et al [10]. They are characterized by optical UV-Visible spectroscopy, fluorescence, photoluminescence. Dehydrogenation of boric acid at 100 ^oC, converts to the polymeric stage, which play a vital role in the energetic species catalyzing the reaction [11-13], in the same reaction liberated water molecule collapse the growth of the reaction, and produced poly boric acid as catalyst shows mild bronsted acidic nature. Boron acids (borinic BR_2 (OH) or baronies, BR $(OH)_2$, boric B $(OH)_3$) have been employed in various applications, including as reaction promoters and catalysts as dyes, as support for derivatization and distillation of sugars, diols, glycosylated proteins and used as detector for carbohydrate derivatives, used as separator as well as in membrane layer transport device [14-25].

Amine based boron polymers like polynoraamines [26], polyacrylamide [27]are applicable in formation of recycle or reusable gas storage materials such as hydrogen storage materials.Borazine-linked polymer fabricated by Jackson et al. [28] exhibited high gas storage capacity due to porous nature and the high surface is up to 2866 $m^2 g^{-1}$. Carbon doping. Anion alloying and cation off-stoichiometry method are used to undergo intrinsic disorderness and local changes for improving the conductivity and performance of polyboranes [87].

CONCLUSIONS

Due to excellent physico- chemical properties of Boron-based polymers, it became a boon to develop next-generation materials for many applications and also has enhanced conducting properties. It can be synthesized by polycondensation, coupling, grafting to form telechelic and block polymers. The development of synthesis strategies can increase the applicability of boron-based polymers. This polymer also play a major role in medicinal as well as in industrial field.

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