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Role of Tailor Made Polymers

Dr. Kanchan Khare

Asstt. Professor, Deptt. of Applied Chemistry, Jabalpur Engineering College, Jabalpur (M.P.), India

Abstract: **The discovery of novel materials with specific properties will always complement the advances in technology. The research for new material is demanded for several prospects with a view to enhance the nature and range of tailor made properties and replace the existing materials by less expensive high performance materials. In time of bottomed out industrial profits in common plastics future polymer chemistry cannot be limited to repetitive improvements of already successful mass polymers, instead its bandwagon is also required in arena of material science as well as life sciences where "polymer thinking" might help to lead new solution of current problem.**

Keywords: **Tailor made properties, high performance polymers.**

1. INTRODUCTION

The concept of polymerization process application to organic and inorganic chemistry has evolved not only synthetic products but also provoked the chemical modification of conventional or existing polymers into new speciality materials with high performance tailor-made properties for target application. Replacement of hazardous methods for the synthetic of intended polymers may bring out economic and rapid ways of obtaining new polymers. The green chemistry focuses its attention on the design manufacture and use of such chemicals which suffices the environmentalists criteria against polymer non-biodegradability by involvement of renewable resources for supporting atom economy, clear chemistry, eco-friendly chemistry and benign by design chemistry[1].

2. CRITERIA FOR HIGH PERFORMANCE POLYMERS

By the term High Performance Polymers it is meant that the polymer which provide high levels of mechanical, physical and / or electrical performance under demanding environmental conditions. Some of the interesting and potentially useful common performance criteria can be listed as below:-

- Mechanical Strength: High Stiffness, High tensile, compressive or shear load, high speed impact.
- Toughness and damage tolerance.
- Fatigue resistance
- Dimensional Stability
- Flame retardance with low smoke and toxic fume generation.
- Thermo-mechanical stability: From cryogenic condition to 350°C.
- Thermo-electrical stability: From high voltage to micro scale applications.
- Thermo-oxidative stability
- Photo-oxidative stability: Resistance against ultraviolet and atomic radiation.

- Resistance to oxygen, aggressive solvents and corrosive fluids, from mundane to aggressive automotive and aerospace fluids etc.
- Resistance against moisture - cyclical "hot-wet" conditions.

3. POLYMERS WITH NEWLY EMERGING SPECIALIZED PROPERTIES FOR HIGH PERFORMANCE

3.1 NANO STRUCTURAL MATERIALS:

Nanotechnology is a group of generic technologies that are becoming crucially important to many industrial fields as the force in this broad field from micro to Nano systems finds role in Automotive, Medical, Pharmaceutical, Analytical, Consumer, Optical to Electron microscopy, structural materials and self assembling material. Eric Drexler has contributed to "molecular nanotechnology" and popularized in his book "Engines of Creation" [2].

3.2 LANGMUIR-BLODGETT (LB) FILMS:

Langmuir-Blodgett (LB) films are typically formed by spreading a molecularly thin layer of molecules at a liquid-gas interface and where molecules of appropriate design, orient due to preferential interactions with either, or both, the liquid or / and gas. The passing of a surface through the interface, if appropriate conditions exists results in the transfer of a layer of single molecule, thickness, to the surface. Repeated passage can result in the addition of further layers. A wide variety of molecules have been configured into such layers, exhibiting a plethora of effects such as optical non-linearity, Piezo electricity and semiconducting behavior. Potential applications include opto-electronic devices, Nanolithography and active layer for gas sensors [3].

3.3 SELF-ORGANISING AND SELF-ASSEMBLING MOLECULAR STRUCTURES:

Self-assembly is defined as spontaneous intermolecular association via non-covalent bonds (eg. electrostatic interactions, hydrogen bonds or hydrophotsic interactions), resulting in thermodynamically stable, well-defined supramolecular structures with dimensions ranging from 10 nm to 10μm [4,5]. Self-organising systems are widely represented in nature, eg; double-helical structures of nucleic acids and bilayers of lipids within cell membranes, with organization and intimately linked function [6,7]. Assembly through non-covalent interactions offer a number of advantages over chemical synthesis involving formation of covalent bonds, it does not require complicated preparative procedures, the reactions are typically fast [8], and the resulting structures may be capable of reversible adaptive rearrangement in response to changes in environment (eg. solvent or temperature). Assembly process opens fascinating possibilities for fabrication of multi functional materials for technological applications where precise control of properties is essential, eg. electronic devices, micro-sensors, separation membranes, catalysts and biomaterials.

3.4 POLYMERS WITH VARYING DEGREE OF POLARITY:

THE POLYELECTROLYTES:

Among the best-known synthetic self-assembling polymeric systems are complexes of charged polymer chains (poly-electrolytes) and oppositely charged small amphiphillic molecules (surfactants) consisting of a polar "head group" and a non-polar tail [9]. The complexation process is an ion-exchange reaction driven by electrostatic attraction between the polymer chain units and the surfactants. Several major types of poly-electrolytes surfactant complexes are described in literature [10-15].

Poly-electrolytes helps in flocculation and filtration to produce water of adequately low turbidities and thus enable complete in activation of virus by chlorination. This is of great public health importance in developing countries where viral diseases are endemic.

3.5 LIQUID -CRYSTALLINE POLYMERS:

Liquid crystal Polymers are one of the most exciting and novel materials with ultra-high performance which has emerged in recent years as engineering plastics, films, fiber forming materials and elastomers. Their low molecular weight analogues are known well over hundred years and have now found extensive use in various fields including display systems and in medical applications. The interest in liquid crystals is primarily due to their unique ability to translate this molecular order into supramolecular effects. Molecular architecture can, therefore control the polymer properties. In general, the different molecular design serve two different purposes, main chain liquid crystals give strength, stiffness and temperature resistance whereas side chain systems give electrical and optical effect [16].

3.6 POLYMERS WITH FUNCTIONALISED DENDRITIC BEHAVIOUR:

In the past few years dendritic molecules [17-19] have attracted an enormous amount of attention and successfully proven to be a new subclass of molecules between the low molecular organic compounds and the conventional high polymeric structures. In particular, dendrimers have a unique well controllable structure and size with perfect branching. Usage of dendrimers due to their unique properties viz. small radius of gyration, lack of entanglement, low viscosity, high solubility amorphous nature etc. includes harvesting low energy photons [20], drug delivery agent [21] and molecular encapsulation [22].

3.7 POLYMERS WITH CONDUCTING PROPERTIES:

The ability to conduct electricity seems an unlikely property for materials better known for their excellent electrical resistance. To persuade polymers to conduct, the polymer designer must provide some mechanism for moving electrons. This can be achieved if the polymer has an extended conjugated structure which allowed electrons to move through the delocalized orbitals. It is also important that the polymer is easily oxidized or reduced because this allows electrons to hop from one chain to another. Thus, the alternating single and double bonded chain of poly-acetylene (PA) provides the archetypical example, which is a semiconductor (band gap=1.5 eV).

3.8 DEGRADABLE POLYMERS:

The degradation of polymers is an important past of modern polymer technology. Degradable plastics, only a few year ago little more than a novelty, are now a hot topic within the plastic industry. Many of the traditional bulk polymers are quite resistant towards environmental degradation, but different modifications can render the materials susceptible to photo-oxidations and/or biodegration. Metal complexes are used, triggering a photo-oxidation with a possibility of later biodegradation. Biodegradable polymers are useful for applications such as sutures, surgical implants, controlled-release formulations of drugs and agricultural chemicals, agricultural mulch etc.

4. CONCLUSION

The polymer chemistry has become a mature science of this era with all advantages of a well established scientific discipline, many heights have been conquered and the harvest is abundant. The role of tailor made polymers is yet to be explored, for conquering upcoming challenges in various fields of technology and its application.

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