REVIEW ON VARIOUS SYNTHESIS TECHNIQUES OF POLYINDOLE AND ITS COMPOSITES

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Abstract
This article reports the review on various synthesis techniques of polyindole and its composites. Numbers of researchers are made their contribution to synthesize the polyindole and its composites using different techniques which are briefly discussed. Most of researchers were used synthesis technique like, electrochemical polymerisation, interfacial polymerization, reversed micelle polymerization, colloidal dispersion to synthesized polyindole and its composites.
Keywords: *Polyindole, Polymerization, Characterization*

Introduction

The quick rise in the number of methods for the synthesis of conducting polymers, in addition to the range of their combinations with other materials, affords the possibility of various kinds of applications. Standard examples of the use of such composite materials are anti-corrosion coatings, radiation shields, electrochromic applications, but also a new category of sensors, prosthetic elements, and other human medicine applications are being developed. Intrinsically conducting polymers (ICPs) are basically conducting in nature caused by the existence of a conjugated π electron arrangement in their structure. ICPs have properties like optical transition at low energy, low ionization potential and high electron affinity [1]. In ICPs high level of conductivity (near metallic) can be gained through oxidation–reduction as well as by using a proper dopant during chemical doping process [1, 2]. Shirakawa et al. synthesized the polyacetylene which was discovery of first ICP [3]. Also, observed that the conductivity of polyacetylene could be enhanced by using chemical dopant.

The comparison with other ICPs there is clear dominance of polyindole. The conductivity and processability of PIN are comparatively superior to other. The thermal stability of PIN is better than other ICPs. From economic point of view, the indole monomer is comparatively less expensive than other monomers used for ICP. The PIN is very easy to synthesized, properties can be explore simply, and it has several potential application [4]. All these factors give advantage to PIN being better to other ICPs.

Here the existing literature reviewed for this study, various synthesis methods of PIN have been verified, such as electrochemical, interfacial polymerizations, reversed micelle polymerization, colloidal dispersion. The various synthesis techniques utilized to prepare PIN are detailed below.

Results and discussion

In recent years researchers synthesized the polyindole and its composites by various synthesis techniques. Such as,

1. Electrochemical polymerisation of indole:

The polymerization of indole monomer through electrochemical route approach is very critical, expensive, non-convenient process. In this synthesis process no additional chemicals are used such as oxidant, surfactant and so on. In this technique, a pair of electrodes was used for the electrolysis process. The electrodes of silver, gold and platinum were reported. Normally electrochemical techniques are effective for the polymerization of indole under: (i) a constant current (galvanostatic); (ii) a constant potential (potentiostatic); and (iii) a potential cycling or sweeping. The synthesis of polyindole through electrochemical technique was carried out by so many researchers by using the small plate of polished stainless steel or piece of indium-tin-oxide (ITO) glass as a working electrode. The platinum wire used as counter electrode and the saturated calomel electrode (SCE) used as a reference electrode [5, 6]. The platinum wire as working electrode and stainless steel as counter electrode were used in this process. The quantity of polymer deposited on the electrode was inhibited by the incorporated charge passed through the cell [7]. Talbi et al. synthesized the polyindole by using both platinum plate and indium tin oxide (ITO) electrodes which was used as working electrodes. Also, the platinum wire used as a counter electrode, while standard saturated calomel electrode (SCE) used as a reference electrode. All potentials are quoted with respect to this reference electrode. Electrochemical studies were monitored by a computer inhibited Potentiostat-Galvanostat [8]. Saraji et al. prepared the polyindole electrodes by cyclic voltammetry method under atmosphere of nitrogen, in a standard three electrode cell via a platinum counter electrode and Ag/AgCl electrode as the reference [9].

2. Interfacial polymerization of indole:

Interfacial polymerization is a typical approach where polymerisation reaction is carried out in the interfaces of two immiscible solvents. PIN has been synthesized by an interfacial polymerisation method via a combination of two immiscible solvents such as water and dichloromethane in the presence of $FeCl_3$ acting as oxidizing agent by koiry et al., H_2SO_4 (aquues) dichloromethane (organic) and ammonium peroxydisulphate used as oxidizing agent by Joshi et al. In this techniques the formation of two separate layers of aqueous (top) and non-aqueous (bottom) phases; the mixture was then kept for polymerization under slow stirring. After 12-24 h, the organic phase was packed with dark-green precipitate of polyindole. The ultimate product is isolated by centrifugation. This technique is useful to synthesize a variety of outcome range from a one-dimensional radially associated nanofiber to a globular formed PIN with a fine size allocation, by the proper selection of appropriate reaction parameters and reagents. The various products of PIN which have morphologies such as tubular, fibrous, rods and their particle sizes are 1 μm, 2-5 μm, 20-50nm respectively [10, 11-13].

3. Reversed micelle polymerization of indole:

Biasutti et al. charge tranfer complex between indole derivatives and methyl viologen in reverse micellar systems. Indole acetic acid (IAA) and indole butyric acid (IBA) was investigated in reverse micelles of sodium bis(ethylhexil sulfosuccinate (AOT) in heptane. In this case AOT/ heptane, the noticeable association containing for IAA and TRP are incredibly higher than in pure water or normal micellar solution [10]

4. Synthesis of polyindole by colloidal dispersion:

PIN is typically synthesized through the oxidative polymerization of indole in a medium like acidic aqueous and is obtained as a precipitate. If a suitable water-soluble polymeric stabilizers such as poly(vinyl alcohol) (PVC), poly(vinyl acetate) (PVAc), poly(ethylene oxide), poly(ethylene), poly(vinyl pyridine) and methyl cellulose are added into the reaction mixture, colloidal PIN particles are produced as an alternative of precipitation. Such a process is called as dispersion polymerisation [14, 15]. The resultant polymeric materials, recognized as composites and blends, are successful combinations of conductive polymers with dissimilar processible non-conducting polymers, so they have combined properties of both materials [16]. Specifically, dispersion polymerization of aniline and pyrrole in the presence of PVC has displayed numerous exciting results [17, 18]. In this method: (a) monomer is completely soluble in media of reaction; (b) but in the similar environment solubility of the synthesized polymer is nil; and (c) its macroscopic precipitation is prohibited through the occurrence of the self-styled steric stabilizer. Thus, such colloids are known as dispersions. Rajasudha et al. chemically synthesized polyindole by colloidal dispersions using sodium dodecyl sulphate, poly(vinyl alcohol) and poly(vinyl acetate) as steric stabilizers. Here poly(vinyl alcohol) and $FeCl_3$ were dissolved in water [19].

Polyindole dispersions consisting of 20–30 nm sized nanoparticles. The particle size depended on the concentrations of monomer and the steric stabilizer. The shape of the particles possibly spherical, globular, granular, cylindrical or branched dendritic structures [19].

Above discussion suggest that the researchers used the various synthesis techniques to synthesize the polyindole and its composites.

Conclusion

The synthesis techniques such as electrochemical, interfacial polymerizations, reversed micelle polymerization, colloidal dispersion are useful to successful synthesis of polyindole and its composites. The size of particle can be differentiating using synthesis techniques, it observes from the above discussion.

References

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