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ABSTRACT

Nanostructured organic polymeric systems are a field of increasing scientific and technological interest, offering the opportunity to polymer and synthetic organic chemists to synthesize a broad variety of promising new materials, with a wide range of applications. One-dimensional (1D) nanostructures of organic conducting polymers possessing π- conjugated systems have attracted the attention of most of the material scientists, engineers and technocrats due to their intrinsic conducting forms, which endow them unique optical and electrical properties. An essential challenge in synthesis of 1D nanostructured organic polymers is, controlling the structures at high yield through practical synthetic routes from a diversified range of materials, rapidly and at reasonably low costs, for industrial applications. Besides, perception of the basic science issues involved in the properties of polymers is relevant to the development of technologies based on nanoscale materials. By being able to fabricate and control the structures of nanoparticles, the scientist and engineer can influence the resulting properties, and ultimately, design materials with desired characteristics.

The research work is based on the synthesis and detailed investigation of 1D nanostructured organic polymeric systems, with particular reference to their optical properties. Nanostructures of five different organic systems namely, polyaniline (PANI), polypyrrole (PPy), polyindene (PIn), poly(indene-co-pyrrole) (CInPy) and polyindole (PInd) have been explored. Inspite of the active research spent on 1D nanostructures of PANI and PPy during the past years, these systems still draw considerable attention in the development of nanoscience, because of their material properties. The influence of interfacial chemical oxidative polymerization method is discussed as a function of polymerization time, on the PANI nanofibers. The study enlightens in detail the variations in the morphological/dimensional, spectral, crystalline and conducting properties of PANI nanostructures with regard to the differences in the synthesis duration. An important consideration in the study involves the comparison of properties at nanoscale dimensions relative to those at larger-scale dimensions. Simultaneously, a bulk material of PANI is synthesized using the conventional chemical oxidative polymerization method and compared with the nanosized PANIs on similar parameters. A similar set of study of the structural properties of nanosized PPy with regard to the variation in synthesis duration, and the introduction of different dopant structures (HCl, $FeCl_3$, p-TSA, CSA & PSSA) into its molecular matrix through interfacial chemical

oxidative polymerization methodology has been undertaken. Besides, it is always interesting to develop specific polymeric nanoarchitectures using material with unique structure and properties that are quite different from the previously reported ones. Novel PIn nanofibers have been obtained using cationic polymerization method and explored with regard to their optical, spectral, chemical, thermal stability & conducting properties. Efforts have been made to improve the conducting properties of nanodimensioned PIn by the copolymerization of indene with pyrrole, to enhance its optoelectronic applications in different nanotechnological fields. The effect of copolymerization in novel CInPy nanofibers is examined in view of the individually synthesized homopolymer nanostructures of PIn and PPy. Novel 1D nanostructures of a fused ring polyheterocyclic polymeric system, PInd have been synthesized using a facile chemical oxidative polymerization method. The structural, optical, spectral and conducting properties of the nanosized PInd is explored with regard to results obtained at the initial stages and enhanced polymerization times. An attempt is made to synthesize 1D nanosized PInd that can retain the intrinsic conducting and optical properties of the polymeric system, curtail the drawbacks of earlier reported globular PInds, and thus, may be applied to various nanotechnological fields.

The synthetic methods portrayed in work offer straightforward chemical oxidative polymerization routes to obtain 1D fibrillar morphology of π- conjugated organic polymeric systems with high yields. The approaches extend advantage over the techniques where, highly sophisticated synthetic routes/instrumentation are applied or tedious post-synthetic processes are required for developing 1D nanostructured polymeric systems. The methods can be further refined and may be used in design & development of nanostructures of similar π- conjugated polymeric systems, involving improved strategies and combinations of various types. Besides, the methods accomplish the ability to control over the optical, spectral, thermal, crystalline and electrical characteristics of the nanosized polymers, and thereby, mould their desired properties for nanotechnological applications. The undertaken work opens up new frontiers in the field of 'Nanochemistry' that deals with the development of methods for synthesizing nanoscopic particles of a desired material and the scientific investigations of the nanomaterial obtained. More specifically, emphasis laid upon the effect on optical properties due to changes in dimensional structures of polymeric systems may provide grounds for constructing optoelectronic devices. An intriguing root to construct nanosystems is to primarily visualize the underlying properties of the nanosized structures withheld in the organization, and the goal of nanotechnology is to improve the control, over how things are built, so that the resulting materials can be of highest quality and useful to mankind. In a nutshell, the synthesis and characterization of the nanosized materials encompasses the advantage of better perceptive of the underlying chemical functionality of the molecules that can be controlled and almost infinitely varied, which shall enable to achieve this goal easier and form the ground for future nanotechnological devices.