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Thermal decomposition kinetics of polypyrrole and its star shaped copolymer

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Abstract Thermal behavior of 2,4,6-tris(4-(1H-pyrrol-1-yl)phenoxy)-1,3,5-triazine monomer, polypyrrole, and their star shaped copolymer, were investigated using TG and DTA methods. It was found that Tria melts at 517 K and after than it starts to decompose. Decomposition proceeded in two stages which were corresponding to removal of branched groups and remaining core structure degradation, respectively. Polypyrrole and copolymer showed similar thermal behaviors. These compounds decomposed in three stages which are removal of solvent, removal of dopant anion and rest of structure decomposition. The calculation of activation energies of all reactions were realized using model-free (KAS and FWO) methods. The graphs were prepared which show the alteration of activation energy with decomposition ratio. Thermal analysis results showed that dopant anion and solvent removal activation energy values for copolymer are lower than polypyrrole. Star shaped loose-packed novel structure greatly facilitates solvent and dopant anion removal from copolymer. It can be concluded also that thermal analysis can be used as predict package structure of conducting polymers.

Keywords FWO · KAS · Star shaped copolymer · Activation energy · Model-free methods

Introduction

The growth in the intensive study of highly conducting polymers began in 1977 with the discovery of the change in the electrical conductivity of poly(acetylene) on doping with Br_2, I_2, and AsFs [1]. Other conjugated polymers which exhibit interesting electrical and electrochemical properties associated with their extended π-bonding system are now known. Polymers containing heterocyclic units in the backbone were found to have notable electrical conductivities and to offer increased stability and processability in both the doped and neutral states when compared with poly(acetylene)s. Among the many poly(heterocyclic)s, polypyrrole (PPy) and its derivatives have aroused great interest. The synthesis, structure, electrochemical, electrical, and physicochemical properties and applications of PPys and their derivatives have been investigated deeply [2] to solve many questions, such as structure–properties relationships, increasing of stability and processability. Building super-structured conducting polymers (CPs) is of great interest because of the novel properties that could arise from such structures. Branched CPs with electronically connected nodes are excellent candidates among this family of super-structured CPs; with such polymers, there should be no need for inter-chain coupling or inter-chain electronic transfer to insure high electronic conductivity [3, 4]. Moreover, this type of material possesses a three dimensional structure which could also improve the conductivity. For these reasons, we have chosen to synthesize 3D star-shaped molecules with pyrrole branches and aromatic and non-aromatic connecting-up.

For the future utilization of CPs, the knowledge of the thermal behavior and stability is important. Although there are an enormous number of papers related to the preparation conditions of PPy with high electric conductivity or mechanical stability [5], there are only a few reports dealing with the thermal stability of PPy [6, 7]. High thermal stability and electrical conductivity will provide CPs with extremely wide applications for the practical

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