SUMMARY
OF THE
RESEARCH WORK
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A comprehensive summary of the work to be incorporated in the thesis entitled “Studies on polymers derived from pyromellitic dianhydride” has been described into two parts.

Part 1: Studies on thermoplastic–thermosetting merged polyimides

Part 2: Studies on coordination polymers

**PART-I: Studies on thermoplastic–thermosetting merged polyimides**

Aromatic polyimides are an important class of high performance polymers due to their excellent thermo-oxidative stability, mechanical strength, electrical properties and high radiation and solvent resistance. Polyimides are generally derived from the reaction of organic diamines with organic tetra carboxylic acids or their dianhydride.

Polymerization by Diels–Alder (DA) reaction is one of the promising trends in the preparation of polyimides. Studies on the application of DA reaction between furan (diene) and maleimide (dienophile) for the synthesis of novel macromolecular materials had bloomed during the past few decades. DA reaction has been applied to the furan heterocycle with growing frequency because of its pronounced dienic character, which makes it particularly suited to...
intervene in the DA cycloaddition reaction as the dienic partner. The use of bismaleimides as dienophiles is very useful because the double bond of maleimide is very reactive towards electron rich dienes, to give DA cycloaddition.

The polyimide materials are often used in the electronics industry, as a high-temperature adhesive, as a mechanical stress buffer, as an insulating layer in the manufacture of digital semiconductor and MEMS chips. Because of their high mechanical stability even at elevated temperatures they are used as bushings, bearings, sockets or constructive parts in demanding applications.

The first investigation on the use of a system involving a bisfuran and a bismaleimide monomer combination was reported by Tesoro and Sastri. Various strategies can be envisaged to synthesize or modify polymer structures by exploiting the reactivity of this heterocycle with various dienophiles by the researchers.

In our laboratory, Patel and his co-workers have reported the studies on polyimides like poly(s-triazine-imide), poly(epoxy-imide), poly(ether-imide), poly(ester-amido-imide), poly(amido-imide), poly (ester-oxysilane-imide), poly(urethane-imide-ester) through DA polymerization of bisfurans and bismaleimides with wide structural variation.

Polyimides are of two types. Thermoplastic polyimides are usually synthesized from poly(amic acid) prepared by the reaction of an aromatic dianhydride with an aromatic diamine followed by cyclodehydration. Frequently, the final imide polymer is insoluble, infusible, and intractable. Hence processing of amic acid solution is used for the manufacturing of articles. Thermosetting polyimides are synthesized from unsaturated monomer e.g. bismaleimides known as thermosetting polyimide. These polyimides are processed in-situ.

Not a single report was found in which the polyimides containing both thermoplastic and thermosetting segments were together. Our main concern was to synthesize novel polyimides from bisfuran and various reported bismaleimides, which possess combination of thermoplastic and thermosetting
moieties. This can be attaining by DA reaction and simultaneous aromatization–imidization reaction. Introduction of pyromellitic segment is defined as a thermoplastic portion and bismaleimide segment is defined as a thermosetting portion.

Part–II: Studies on Coordination polymers

In recent years, the design and construction of coordination polymers (an inorganic polymer structure containing metal ion centers linked by ligands), often referred to as metal–organic frameworks (MOFs), have attracted increasing attention. Numerous coordination polymers have been reported not only because of their intriguing variety of architectures and topologies but also for their properties of high porosity and enormous internal surface areas. These properties have potential applications in clean energy, such as storage media for methane, hydrogen and acetylene or as absorbents or membrane fillers in separation and purifications of chemicals. Coordination polymers can be used in catalysis, magnetism, luminosity and chemical sensors.

The structures of coordination polymers are greatly depending upon the structure of the organic ligands, the coordinative geometry of metal ions, metal–ligand ratio and other factors. Among various organic ligands, multicarboxylate ligands are often used as multifunctional organic ligands, not only because of their various coordination modes to the metal ions, but also because of their ability to act as H-bond acceptors and donors assembling supramolecular structures. For example, 1,2,4,5-benzenetetra carboxylate, 3,3’,4,4’-biphenyltetra carboxylic acid, 1,1’-biphenyl-2,3’,3,4’-tetra carboxylic acid and methylene diiso phthalic acid have been extensively used for the synthesis of various coordination polymers.

On the other hand, the use of auxiliary N-containing ligands is also an effective method for the framework formation of coordination polymers owing to the fact that they can satisfy and even mediate the coordination needs of the metal center and consequently generate more meaningful architectures. In our laboratory, Patel and his co-workers have reported synthesis and characterization and their
microbicidal studies of various coordination polymers synthesized from 8-hydroxy quinolene and their derivatives.

The coordination polymers based on bisamic acid of pyromellitic dianhydride has not received any attention academically; hence with the aim of investigating the influence of bisligands (containing carboxylic and amide –N group) on the frameworks of coordination polymers, we have carried out the studies for the reaction of transition metal (II) salts with various novel bisligands. Novel bisligands were synthesized from pyromellitic dianhydride and various aromatic amines.