

PREFACE

Polymers are high-molecular-weight compounds that are so important to man and his modern technology. It was not until the 1930's that the science of polymers began to emerge, and the major growth of the technology of these materials came even later. According to the latest report one tenth of chemists, chemical engineers and physicists are associated with polymeric materials and research, throughout the world. There are six major areas of application for polymers (1) plastics, (2) rubbers or elastomers, (3) fibers, (4) surface finishes and protective coating, (5) adhesives and (6) electrical conductors. Despite the fact that all six applications are based on polymer, and in many cases the same polymer is used in two or more, the industries grew up pretty much separately. It was only after Dr. Herman Staudinger proposed the "Macromolecular hypothesis" in the 1920's explaining the common molecular makeup of these materials (for which he won the 1953 Nobel Prize in Chemistry) that polymer science began to evolve from the independent technologies. Thus a sound fundamental basis was established for continued technological advances.

The aim of this work is to study the kinetics of polymerization of monomer methyl acrylate (MA) with an added initiator Peroxodisulphate in the presence of low and high power ultrasound and hence synthesize poly (methyl acrylate) in the solid form and to study its thermal and electrical properties. In addition to this the thermal properties of poly (methyl methacrylate) (PMMA) / Montmorillonite (MMT) clay nanocomposites were also investigated. In the presence of low power ultrasound two sample of PMA were synthesized. In the presence of high power ultrasound fifteen samples of PMA were synthesized. In the presence of high power ultrasound two samples of PMMA-MMT clay nanocomposites were synthesized.

The investigations carried out in the present work are summarized below in eight chapters.

The first chapter deals with the basic concepts of polymers and polymerization techniques. The uses of ultrasound in chemistry is known as sonochemistry. The sonochemical synthesis of various polymers is reviewed from the existing latest literature. The kinetics of vinyl polymerization is also reviewed. The photoacoustic studies on various substances are also reviewed. The existing electrical conducting mechanisms of various polymers are also reviewed. The research works on polymer clay nanocomposites are also reviewed. The scope of this work is explained in this chapter.

The second chapter deals with the synthesis of poly (methyl acrylate) from monomer methyl acrylate, added initiator Peroxodisulphate in the presence of low power and high power ultrasound. The characterization methods such as differential scanning calorimetry, Thermo Gravimetric Analysis, X-ray Diffraction, Atomic Force Microscopy, Scanning Electron Microscopy, Extended Photoelectron Spectroscopy, Energy Dispersive X-ray. Spectroscopy are also briefly explained.

The third chapter contains investigations on the chemical kinetic measurements, photoacoustic measurements, thermal expansion measurements made on poly (methyl acrylate) synthesized using low power ultrasound ($5.5\text{W}/\text{cm}^2$).

The fourth chapter deals with the photoacoustic measurements, thermo gravimetric measurements, glass transition temperature measurements, electrical conductivity measurements on Poly (methyl acrylate) samples synthesized by high power ultrasound ($100\text{W}/\text{cm}^2$) under various sonication periods.

The fifth chapter presents with the Atomic Force Microscopic studies made on poly (methyl acrylate) synthesized by low power and high power ultrasound under various sonication periods.

The sixth chapter contains investigations on the thermal studies made on poly (methyl methacrylate) montmorillonite clay nanocomposites.

The seventh chapter deals with and indigenously designed Photoacoustic spectrometer for thermal measurements and a digitalized mechanical screw gauge for ultrasonic velocities studies in liquids.

In the chapter eight the results are tabulated and discussed with references and possible and probable conclusions are drawn.

List of Publications in National / International Journals

1. Dependence of Thermal Diffusivity on Sonication Period in Poly (methyl acrylate) by Photoacoustic Technique.
M.A.Jothi Rajan, T.S.Vivekanandam, N.Sankar, K.Ramachandran, and S.Umapathy.
Journal of the Acoustical Society of India, **31**, 285 (2003).
2. Variation of Thermal Diffusivity of PMA on Ultrasonication Period by Photo acoustic Phase Measurements.
M.A.Jothi Rajan, T.S.Vivekanandam, and S.Umapathy.
NDT.net-The e-journal of Nondestructive Testing,**9**(7) (2004).
3. Heat Transfer in Poly (methyl acryl ate) by Photo acoustic Measurements.
M.A.Jothi Rajan, T.S.Vivekanandam, S.K.Ramakrishnan, K.Ramachandran, and S.Umapathy.
Journal of Applied Polymer Science, **93**, 1071 (2004).
4. Construction of a Low Cost Photoacoustic Spectrometer for Characterization of Materials.
M.A.Jothi Rajan, T.S.Vivekanandam, Arockiam Thaddeus, T.Mathavan, T.S.Vivekanandam and S.Umapathy.
Macromol.Symp.**222**, 287 (2005).
5. The Measurement of Thermal Diffusivity in poly (methyl acrylate) by Photo acoustic Technique.
M.A.Jothi Rajan, T.Mathavan, T.S.Vivekanandam and S.Umapathy.
Journal of Applied Polymer Science, **100** (5), 3756, (2006).

6. Thermal Properties PMMA/Montmorillonite Clay Nanocomposites.

M.A.Jothi Rajan, T.Mathavan, A.Ranasubbu, Arockiam Thaddeus,
V.Fragrance, Latha, T.S.Vivekanandam and S.Umapathy.

Journal of Nanoscience and Nanotechnology, **6**(12), 3993 (2006).

7. Polymerization of Methacrylate in the Presence of Ultrasound and
Peroxodisulphate.

M.A.Jothi Rajan, T.Mathavan, T.S.Vivekanandam and S.Umapathy.

Journal of Applied Polymer Science,(to appear).

8. Sonochemical Decomposition Studies on Peroxodisulphate.

M.A.Jothi Rajan, T.Mathavan, T.S.Vivekanandam and S.Umapathy

Journal of Ultrasonics Sonochemistry, (Communicated).

List of Presentation in National / International Conferences

1. “Dependence of Thermal Diffusivity on sonication period in Poly (Methyl Acrylate) by photoacoustic technique” – presented in NSA – 2003 held from 29 October – 1 November 2003 at Pune, India.

Authors: **M.A.Jothi Rajan**, T.S.Vivekanandam, N.Sankar, K.Ramachandran and S.Umapathy.

2. “Sonochemical decomposition of peroxodisulphate – An efficient initiator for polymerization” – presented in ICMAT 2003 held from 7 – 12 December 2003 at Singapore.

Authors: **M.A.JothiRajan**, T.S.Vivekanandam, K.Ramachandran and S.Umapathy.

3. “A study of heat transfer in poly (methyl acrylate)by photoacoustic technique” – presented in ICMAT 2003 held from 7 – 12 December 2003 at Singapore.

Authors: **M.A.Jothi Rajan**, T.S.Vivekanandam, K.Ramachandran and S.Umapathy.

4. “Construction of a Low Cost Photoacoustic Spectrometer for characterization of materials” – Presented in 2nd ICPSI held from 11 – 13 July 2004 in Lorient, France.

Authors: **M.A.Jothi Rajan**, Arockiam Thaddeus, T.Mathavan, T.S.Vivekanandam and S.Umapathy.

5. Thermal Properties of PMMA/Montmorillonite Clay Nanocomposites – Presented in ICMAT 2007 held from 01-06 July 2005 at Singapore.

Authors: **M.A.Jothi Rajan**, T.Mathavan, A.Ramasubbu, Arockiam Thaddeus, V.Fragrance Latha, T.S.Vivekanandam and S.Umapathy.

6. “Chitin – A Promising Biopolymer for curing Coronary Heart Disease” – presented in ICMMB – 15 held from 6 – 8 December 2006 in Singapore.

Authors: **M.A. Jothi Rajan**, T.Mathavan, V.Ganesan, Arockiam Thaddeus, Fragrance Latha, T.S.Vivekanandam, P. S.Dhandapany and S.Umapathy.

7. “Photoacoustic Spectroscopy – A novel characterization technique in the nano range” – presented in 2nd Vienna International conference on Micro- and Nano Technology, held from 14 – 16 March 2007 at Vienna, Austria.

Authors: **M.A. Jothi Rajan**, T.Mathavan, T.S.Vivekanandam, and S.Umapathy.

8. The Nano Divide: Fictions, Facts and Bioethical concerns”- presented in ICMAT 2007 held from 01-06 July 2007 at Singapore.

Authors: **M.A. Jothi Rajan**, T.Mathavan, Arockiam Thaddeus, Fragrance Latha, T.S.Vivekanandam, S.Umapathy and B Mathialagan.

9. “A Novel Biomolecule Protonated Polymer: Synthesis and Characterization” - presented in ICMAT 2007 held from 01-06 July 2007 at Singapore.

Authors: **M.A. Jothi Rajan**, T.Mathavan, T.S.Vivekanandam, and S.Umapathy.

10. “Sonochemical Synthesis of Poly (Methyl Acrylate)” - presented in ICMAT 2007 held from 01-06 July 2007 at Singapore.

Authors: **M.A. Jothi Rajan**, T.Mathavan, T.S.Vivekanandam, and S.Umapathy.

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