IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO - IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

A Method for Synthesis of Polymers and Copolymers

IITM Technology Available for Licensing

Problem Statement

- The production of Synthetic petrochemical based polymers **nonrenewable resources** are used and the **ultimate fate of these large-scale commodity polymers** are its two major drawbacks which are the **hurdles** in manufacturing process of High molecular weight polymers with **desired properties**.
- **$FeCl_3 \cdot 6H_2O$, $RuCl_3 \cdot H_2O$ and $FeCl_2 \cdot 4H_2O$** are found to be **bulk polymerization catalysts** for the ring opening polymerization of **ε-caprolactone (CL), δ-vaierolactone (VL), β- butyrolactone (BL), lactide (LA).**
- The present patent discloses the **Method** of further **enhancing** the polymerization technique to **synthesize polymers** having desired physical characteristics such as average molecular weight with in an **eco-friendly & cost effectively.**

Technology Category/ Market

Chemistry & Chemical Analysis

Industries: Plastics & Engineered Plastics, Chemicals, Healthcare, Polymers, Synthetic petrochemical based polymers, Polymer Chemistry, Organometallic chemistry

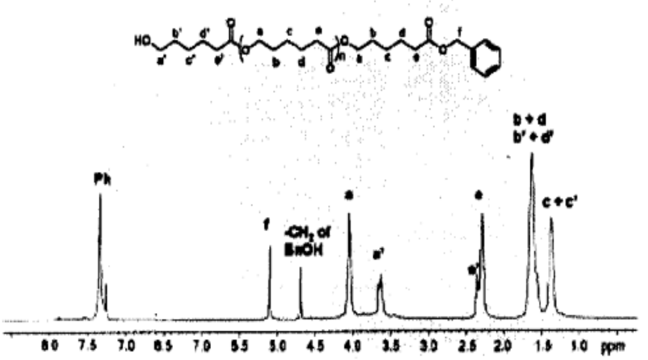
Applications: packaging, making biomedical devices, orthopedic devices, tissue bone repairing & engineering, controlled release of active ingredients in pharmaceuticals.

Market: The Polymers Market size is expected to reach **$790 B by 2027**, after growing at a **CAGR of 5.5%** during the forecast period **2022-2027.**

Technology

This invention discloses a **process** of **activated monomer ring opening mode of polymerization** for producing a polymer from a corresponding **cyclic monomer** such as lactide and lactones with an **active catalyst** to achieve **high number average molecular weight (Mn) polymer** having desired **physical properties**, characterized in **the selected catalyst being simple halides containing Group 8 metals.**

Fig. 1 shows HNMR spectrum of the crude product obtained from a reaction between CL and RUCI3 H2O along with BnOH in 15:1:2 ratio



Characterising

- The **catalyst** used is water
- The **mediating agents** used are **nucleophiles** (such as the **alcohol**).
- The **selected** metals are **environmentally benign metals (the constituents in mammalian anatomy).**
- The **monomer and the metal halide feed ratio** is generally **200:1 molar ratio**.
- The **metal halide catalyst** selected is for use with lactone monomers such as
- **ε-caprolactone (CL), δ-vaierolactone (VL), β- butyrolactone (BL) and lactide (LA).**
- The **ratio** of the **monomer** and the **halide** for **CL** polymers is **0.5 mL of CL (0.54 g, 4.71 mmol)** & **23.6 pmol** of **metal halide.**
- The **ratio** of the **monomer** and the **halide** for **VL** polymers is **0.25 mL of VL (0.27g, 2.69 mmol)** & **13.5 pmoi** of **metal halide**.
- The **ratio** of the **monomer** and the **halide** for **BL** polymers is **0.25 mL of BL (0.26g, 3.06 mmol)** & **15.3 pmol** of **metal halide**.
- **The molecular weight Mn** is further varied by varying the **feed ratio** of the **monomer** and the **mediating agents.**

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Key Features / Value Proposition

- **High average molecular weight polymers**
- **Bulk Production, Biodegradable, Eco-friendly & Economical.**
- Catalyst residues are **potentially harmless**
- **Readily available commercial inorganics are used as catalysts.**
- **The anhydrous $FeCi_3$ alone can be used catalytically for the bulk polymerization of CL, VL and BL to produce high number in average molecular weight (A/fn) polymers.**

TRL (Technology Readiness Level)

TRL – 2; Technology concept formulated

Intellectual Property

IITM IDF Ref: 801

IN Patent No. 263655 (Granted)

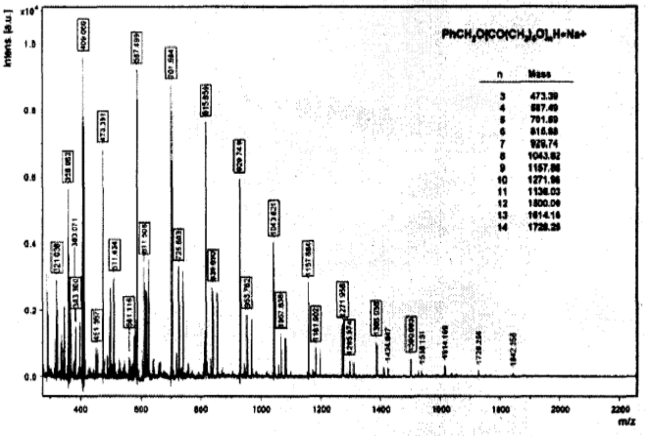
Research Lab

Prof. Debashis Chakraborty

Department of Chemistry

Images

Fig 2 MALDI-MS of the crude product obtained from a reaction between CL & RUCI3H2O along with BnOH in 15:1:2 ratio.



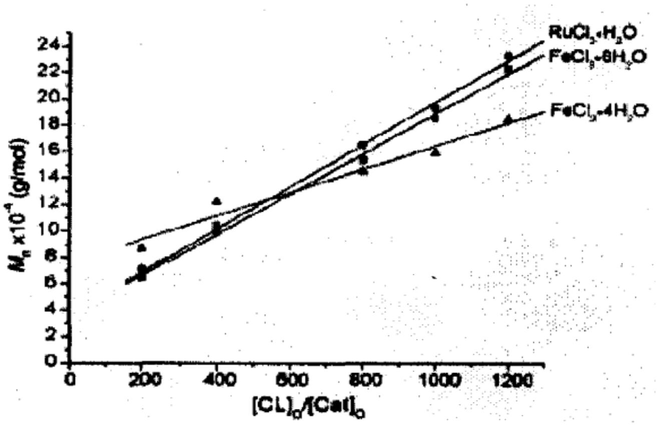


Fig. 3 Plot of Mn (vs polystyrene standards) vs [CL]o/[Cat]o for CL polymerization at 2rC using FeCIa- 6H2O, RuCly H2O and FeCi? 4H2O.

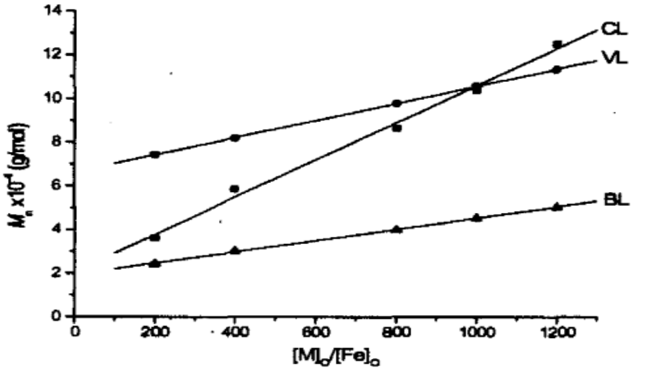


Fig. 4. Plot of A/fn (vs polystyrene standards) vs [M]o/[Fe]o for CL, VL & BL polymerization at 27 "C using FeCly 6H2O.

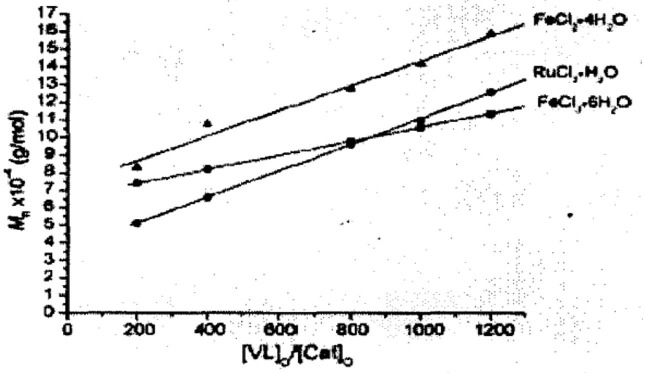


Fig.5. Plot of Mn (vs polystyrene standards) vs [VL]d/[Cat]o for VL polymerization at 27''C using FeCiy 6H2O, RuCly H2O and FeCl2- 4H2O.

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