IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
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Industrial Consultancy & Sponsored Research (IC&SR)

Metal Free Catalysts for the Ring-Opening Polymerization of cyclic Esters and Lactide
IITM Technology Available for Licensing

Problem Statement

- **Synthetic petrochemical-based polymers** have had a tremendous industrial impact, including **two major drawbacks** such as **non-renewable resources in the production** of polymers, & ultimate fate of these **large scale commodity** polymers.
- Further, a few non-patent literature discussed about the ring opening polymerization which has clearly been stimulated by the promising results obtained with pyridines & phosphines.
- Further a few patent literatures discussed regarding various polymerization reaction for preparation of poly lactides, however those metal catalyst suffers from extreme hydrolytic sensitivity & limited solubility features which restricts to use those catalyst
- Hence, there is a need to address the issues & present invention provides the sustainable solution to mitigate above issues.

Technology Category/ Market

Technology: Metal Free Catalysts for the Ring-Opening Polymerization;
Industry: Home Appliances, Surgical/Medical applications, **Applications:** Flexible Films, rigid containers, drink cups, medical applications.
Market: The global market is projected to grow at a **CAGR** of **15.6%** during forecast period of **2021** to **2027.**

Intellectual Property

IITM IDF Ref. 869; Patent No.312778

Technology Readiness Level)

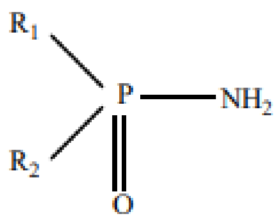
TRL-3/4, Proof of Concept & validated in Lab

Research Lab

Prof. Debashis Chakraborty
Department of Chemistry,

Technology

- Present invention describes a **process for synthesizing an environmentally benign biodegradable polymer** with a high number average molecular weight M_n comprises of **ring opening polymerization** of a **selected monomer of ε-caprolactone (CL) or L-lactide (LA)** with an active catalyst and **benzyl alcohol** in a **predetermined feed ratio** and in a **solvent** free condition.
- The selected catalyst is having a general formula: wherein
- **R1** may be NH_2 or – OEt;
- **R2** may be – OEt or Oph,



1. The process involves method for **synthesizing an environmentally benign biodegradable polymer;**
2. The feed ratio of **monomer, catalyst & benzyl alcohol** ranges from **200:1 to 1000:1 or 200:1:3 to 200:1:20** and more preferably **200:1 or 200:1:3;**
3. The number **average molecular weight** of the **polymer** is between **2.0 kg/mol & 80.78 kg/mol** & molecular weight distribution is between **1.1 and 1.3**.

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Key Features / Value Proposition

❖ ***Technical Perspective:***

1. Present patent provides a **polycaprolactone** which is **synthesized from the selected monomer εcaprolactone (CL)**.
2. Further, present patent provides a **polylactide** which is **synthesized** from **the selected monomer L-lactide (LA)**.

❖ ***Industrial Perspective:***

1. Present Patent is utilizing **metal free catalyst** & **used** for **biomedical** application.
2. It is an **eco-friendly, green & sustainable** process of **synthesis of biodegradable polymers using new catalysts**.
3. **Cost-effective process & environmentally benign biodegradable polymer employing active metal free catalyst.**

Images with Experimental Data

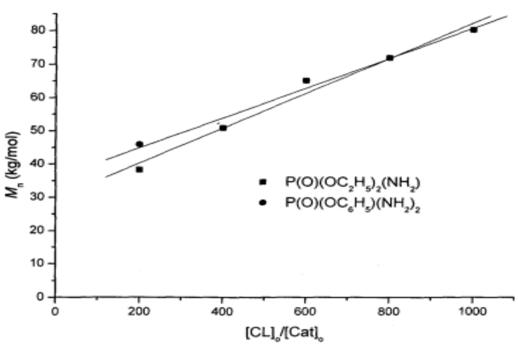

FIG.1: Illustrates the Plot of M_n vs $[CL]_0/[Cat]_0$ for CL Polymerization at 80°C using the catalyst

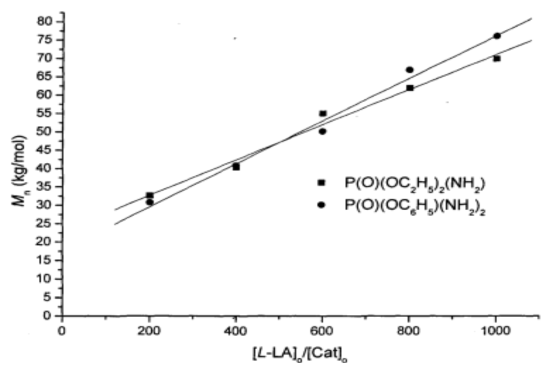

FIG.2: Illustrates the Plot of M_n vs $[LA]_0/[Cat]_0$ for LA Polymerization at 150°C using the catalyst

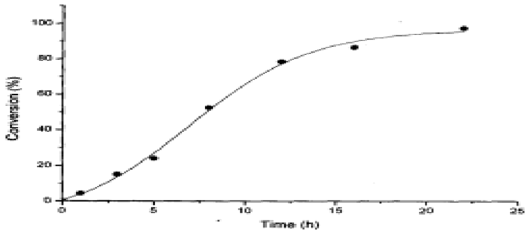

Fig. 3.

FIG.3: Illustrates the CL conversion vs time plot using the catalyst 1

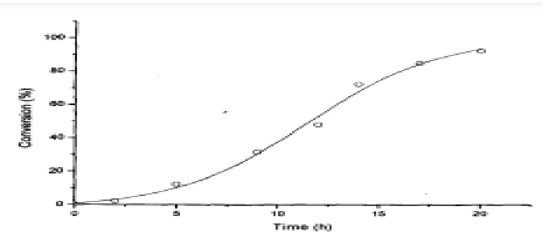

Fig. 4

FIG.4: Illustrates the LA conversion vs time using catalyst 1

Table 1: Results of CL polymerization with 1 at 80 °C.

Catalyst	$[CL]_0/[Cat]_0$	t^a (h)	10^3 M_n ^{b}(Kg/mol)	MWD
1	200	24	38.30	1.1
1	400	27	50.97	1.3
1	600	29	65.43	1.2

Table 2 Results of LA polymerization with 1 at 150 °C.

Entry	$[LA]_0/[Cat]_0$ $/[BnOH]_0$	$[LA]_0$ $/[BnOH]_0$	t^a (h)	Yield (%)	10^3 M_n ^{b}(Kg/mol)	PDI
1	200:1:0	-	24.0	98.0	38.3	1.2
2	200:1:3	66.66	20.0	98.2	3.4	1.1
3	200:1:5	40	17.5	99.0	3.1	1.1

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