



# IIT MADRAS

Indian Institute of Technology Madras

Technology Transfer Office  
TTO - IPM Cell



## Industrial Consultancy & Sponsored Research (IC&SR)

### A METHOD OF PREPARING ALIPHATIC POLYCARBONATES BY ROCOP OF EPOXIDE AND CO<sub>2</sub> VIA ORGANOCATALYST

IITM Technology Available for Licensing

#### PROBLEM STATEMENT

- Traditional petroleum-based polymers are **non-renewable**, slow to degrade, and contribute significantly to landfill waste and CO<sub>2</sub> emissions, exacerbating climate change.
- Research going on **CO<sub>2</sub> as a feedstock for polymer production**, aiming to reduce the environmental impact of conventional polymers.
- Metal-based catalysts have shown effectiveness in polymerizing CO<sub>2</sub> with epoxides, they pose issues such as **complex ligand synthesis, toxicity**.
- There is a need for the organocatalytic systems, specifically using **tert-butyl hypochlorite and iodine**, which offer a **metal-free, more efficient, and environmentally friendly** alternative for the production of aliphatic polycarbonates from CO<sub>2</sub>.

#### TECHNOLOGY CATEGORY/MARKET

**Technology Category:** Chemistry & Chemical Analysis

**Industry:** Aliphatic polycarbonates

**Application:** Food storage containers, refrigerator, Microwave, solid state battery, Coatings, Adhesives, sealants, automotive parts and apparel.

**Market:** The global polycarbonate market was valued at USD 16.9 billion in 2022 and is poised to reach USD 31 billion by 2032.

#### INTELLECTUAL PROPERTY

IITM IDF Ref.: 2753

Patent No: IN 553938

#### TRL (Technology Readiness Level)

TRL-4: Technology validated in lab

#### Research Lab

- **Prof. Debashis Chakraborty**  
Department of Chemistry

#### TECHNOLOGY

- The method uses CO<sub>2</sub> and epoxide reactions to produce biodegradable aliphatic polycarbonates, offering a sustainable alternative to petroleum-based polymers.
- The reaction is catalyzed by a metal-free system using tert-butyl hypochlorite and iodine (I<sub>2</sub>), avoiding the drawbacks of metal-based catalysts such as toxicity, complexity, and contamination in the final product.
- The process involves heating the reaction mixture at 60–100°C (optimally 80°C) for 8-16 hours (typically 12 hours) and pressurizing with CO<sub>2</sub> at 20–60 bars (optimal pressure 40 bars) to achieve polycarbonate formation.
- Suitable epoxides include cyclohexene oxide (CHO), propylene oxide, styrene oxide, or mixtures. These epoxides react with CO<sub>2</sub> to produce the desired polycarbonates through ring-opening copolymerization (ROCOP).
- The resulting polycarbonates can be used in medical (surgical instruments, drug delivery) and consumer applications (food packaging, solid-state batteries), highlighting the versatility and commercial potential of the technology.

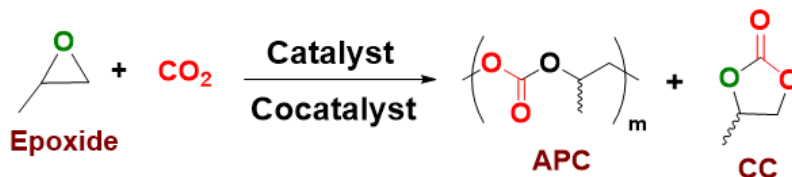
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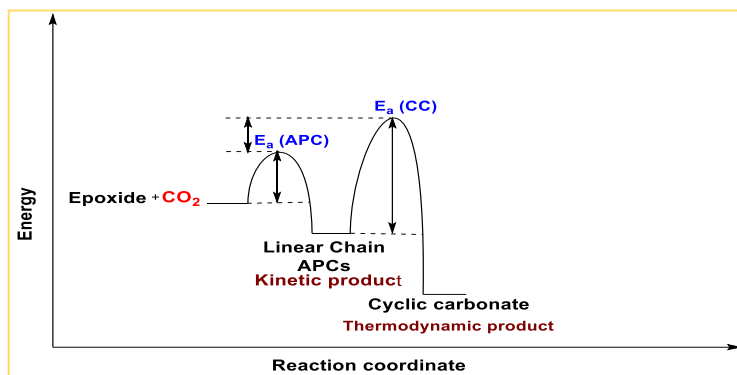
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The reaction of epoxide and CO<sub>2</sub> results in the formation two plausible products - kinetically controlled linear chain aliphatic polycarbonates and thermodynamically controlled cyclic carbonate.



Qualitative energy profile diagram for ROCOP of epoxide and CO<sub>2</sub>

### Key Features / Value Proposition

- Novel method for preparing aliphatic polycarbonates by utilizing tert-butyl hypochlorite and iodine.
- The epoxide used in the method can be selected from a wide range of compounds, including cyclohexene oxide (CHO), propylene oxide, styrene oxide.
- The method enables fine-tuned control over the reaction conditions, including the ratio of tert-butyl hypochlorite to iodine (ranging from 0.5:1 to 1:0.5), the heating temperature (60 to 100°C, specifically 80°C), and the pressurization with CO<sub>2</sub> (from 20 to 60 bars).
- End product suitable for medical applications such as surgical instruments, drug delivery systems, hemodialysis membranes, and blood filters, as well as for food packaging, beverage packaging, and solid-state batteries.
- Eco-friendly route to produce degradable polycarbonates.
- This invention integrates CO<sub>2</sub> as a key reactant. This reduces dependence on fossil fuels.
- The use of tert-butyl hypochlorite and iodine as catalysts in the presence of CO<sub>2</sub> enhances the efficiency of the polymerization reaction compared to conventional catalysts.
- The key benefits of this invention are its environmental friendliness, enhanced catalytic efficiency, flexibility in starting materials, and broad industrial applicability.

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