

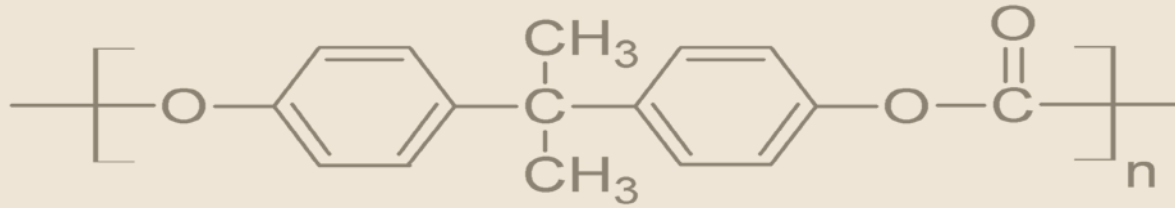
Greener Synthesis of Lexan

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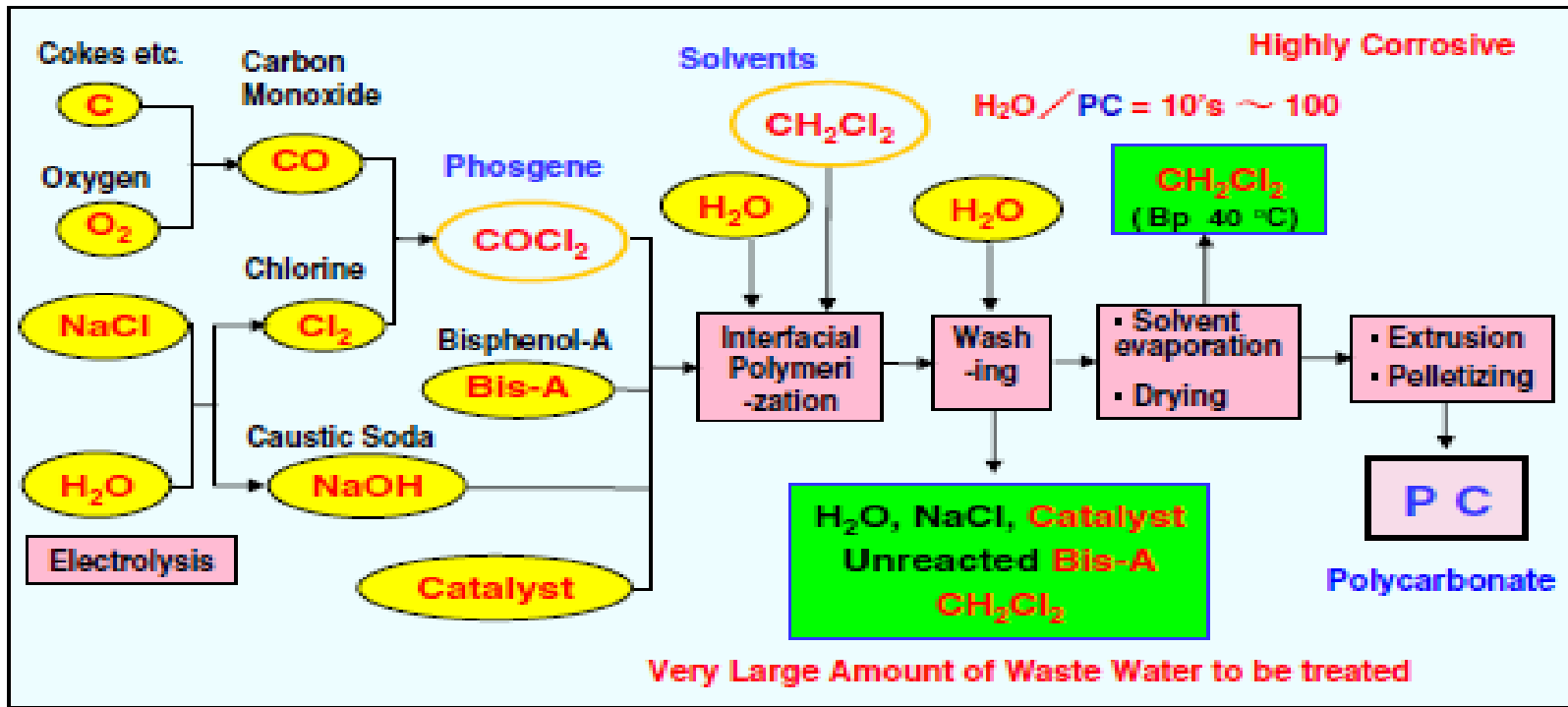
CHEM 483

April 27, 2015

Polycarbonate- Properties and Applications



Conventional Phosgene Process

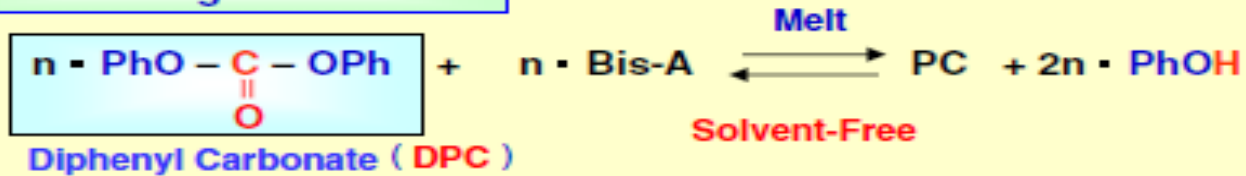


Drawbacks of Phosgene Process

- Phosgene and Methylene Chloride Use
- Waste Water
- Corrosion of Equipment
- Chlorine and Sodium Hydroxide production create higher cost
- Chlorine impurities in product affect properties of product (heat resistance)

Transesterification Process

Non- Phosgene Process



1. Difficulties in DPC Production

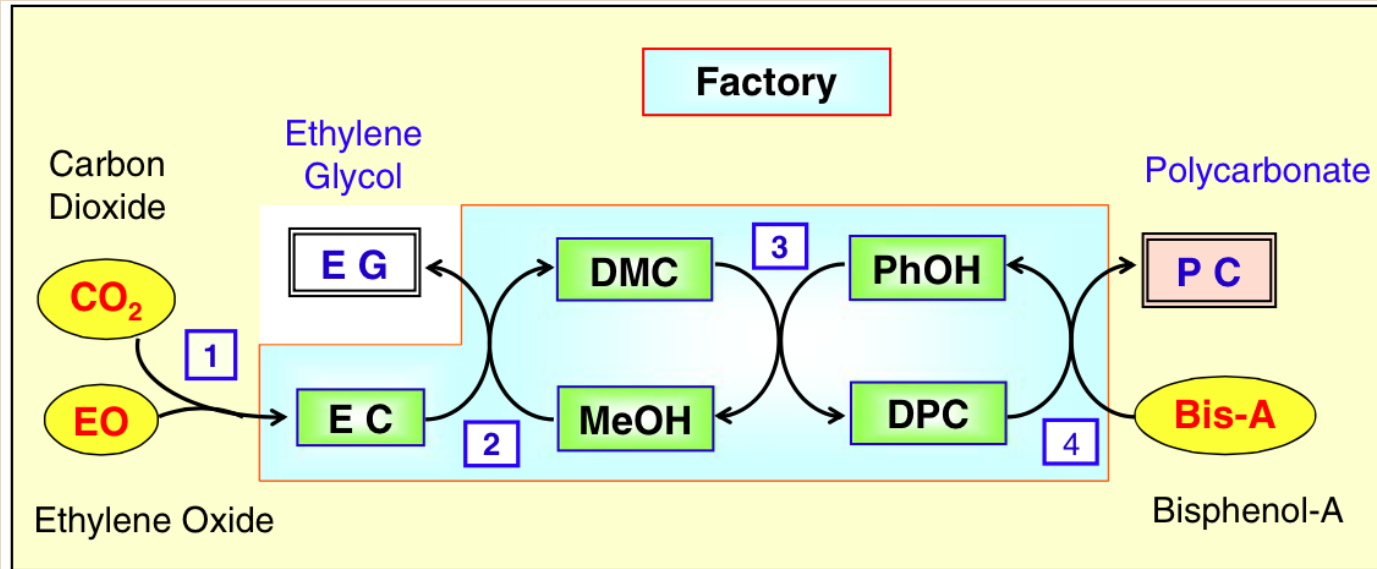
- (1) **Ultra High Purity** : Cl < 1 ppb, Metals (Fe, Na, Ti, Co, ...) < 10 ppb
- (2) **Low Cost** : Productivity, Yield & Selectivity must be High

2. Difficulties in Melt Polymerization (Never Discoloration !!)

PhOH must be removed from **Ultra High Viscous PC**

- (1) Need for High Temp. & Vacuum : > 300°C, < 1 mmHg
- (2) Need for reactor : **Effective Surface Renewal** of high viscous material

Lexan Production from CO₂



○ : Raw Materials, □ : Intermediates, □ : Products, 1 - 4 : Reactions

EC : Ethylene Carbonate

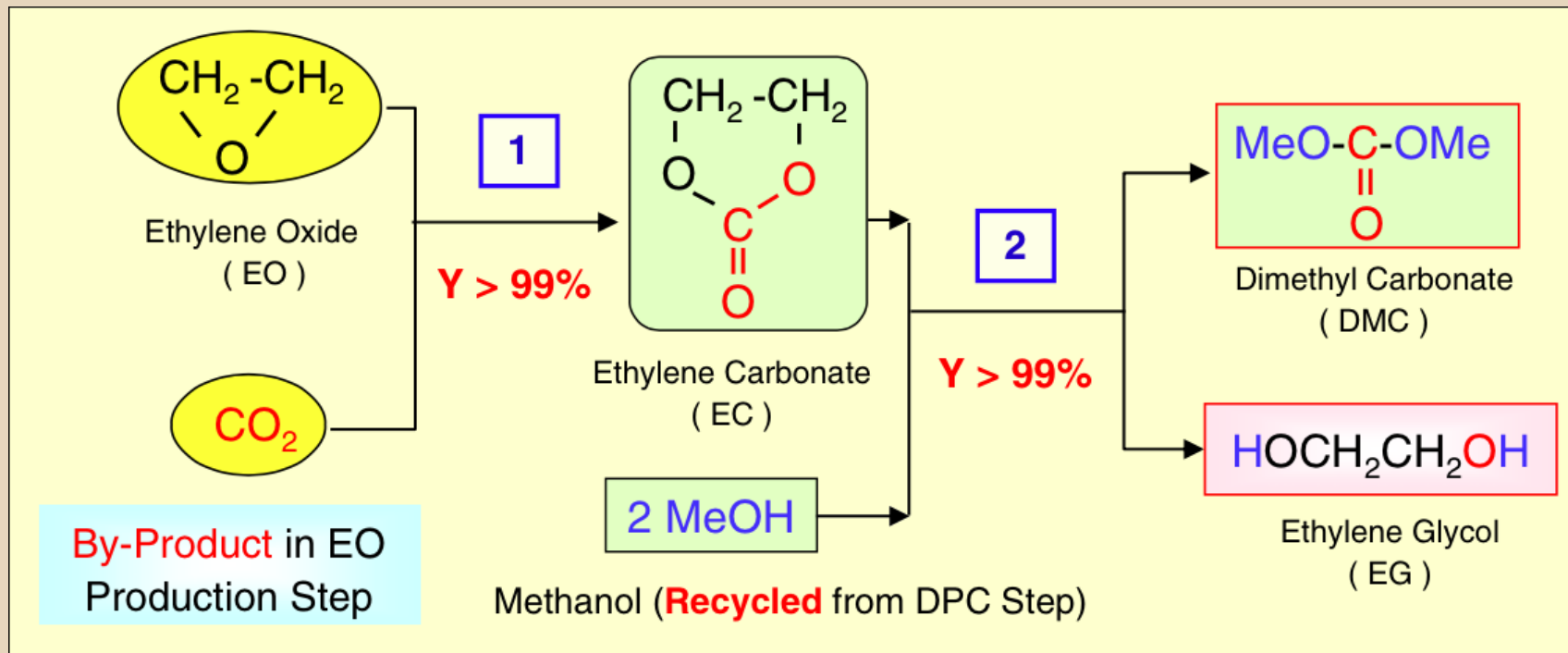
DMC : Dimethyl Carbonate

PhOH : Phenol

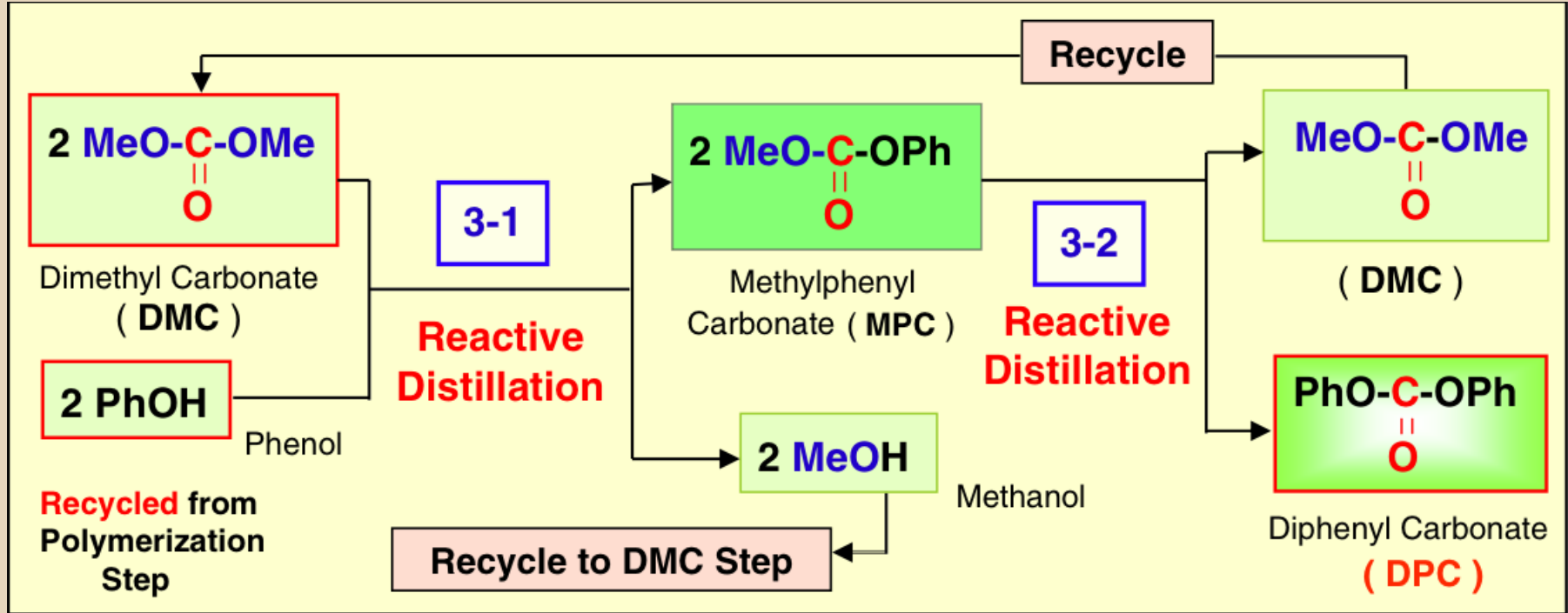
MeOH : Methanol

DPC : Diphenyl Carbonate

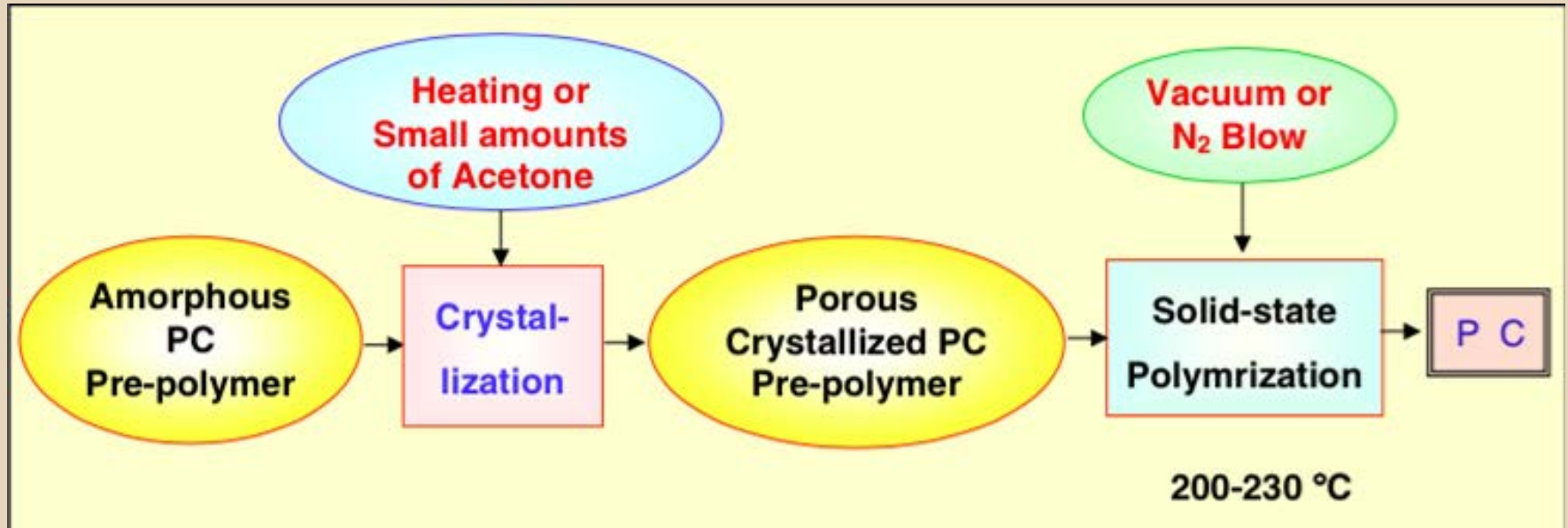
Dimethyl Carbonate (DMC) and Ethylene Glycol (EG) Production Step



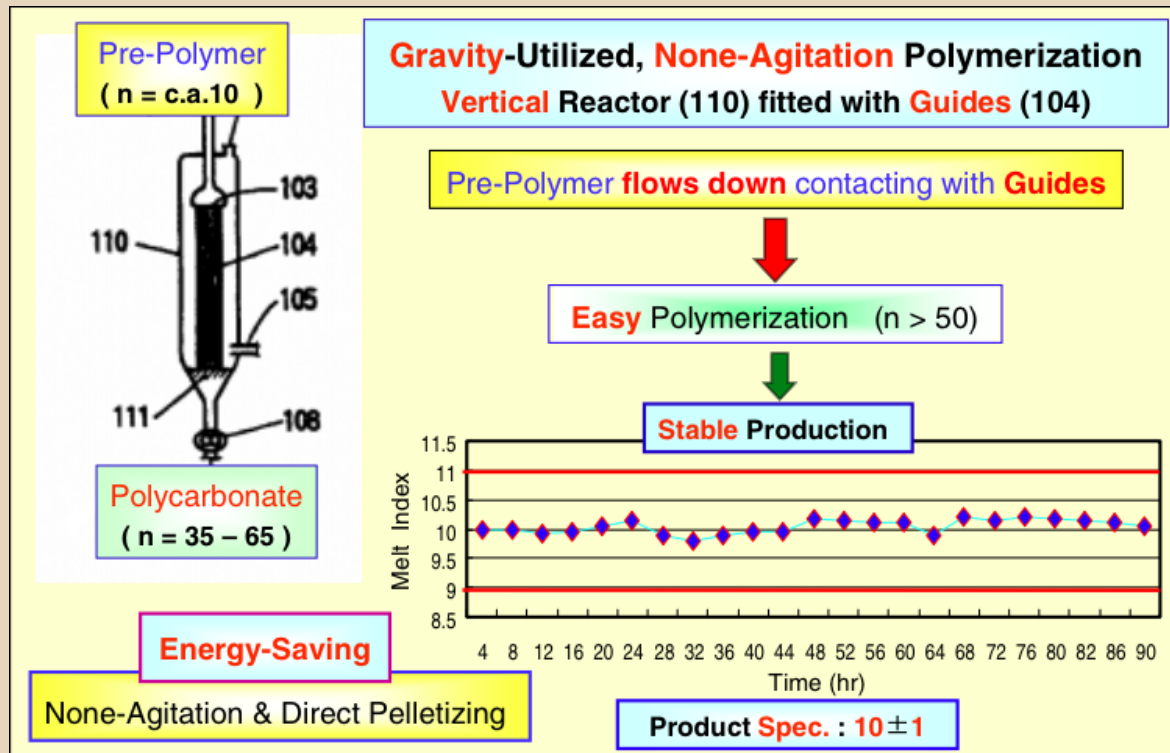
Diphenyl Carbonate (DPC) Production Step



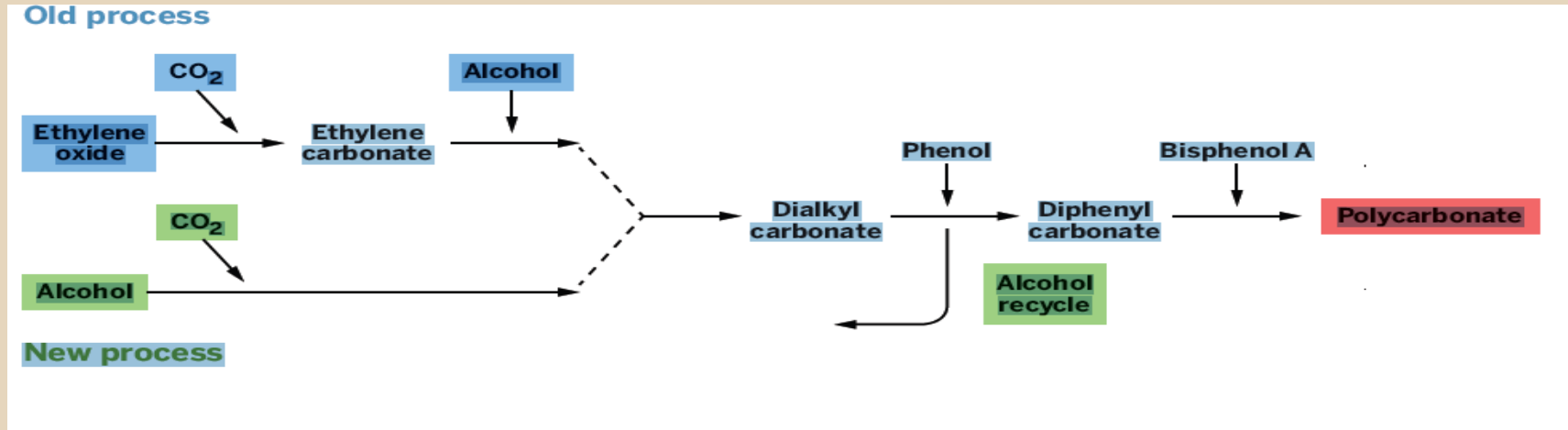
Solid-State Polymerization of PC



Gravity-Utilized, Non-Agitation Polymerization



A Greener Way to Lexan



12 Principles of Green Chemistry

Green Chemistry

Everyone's Doing It!

The 12 Principles of Green Chemistry

A framework for designing or improving materials, products, processes and systems.

1. Prevent Waste
2. Atom Economy
3. Less Hazardous Synthesis
4. Design Benign Chemicals
5. Benign Solvents & Auxiliaries
6. Design for Energy Efficiency
7. Use of Renewable Feedstocks
8. Reduce Derivatives
9. Catalysis (vs. Stoichiometric)
10. Design for Degradation
11. Real-Time Analysis for Pollution Prevention
12. Inherently Benign Chemistry for Accident Prevention

*Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press: New York, 1998, p.30.
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www.acs.org/greenchemistry

A New Kind of Chemistry

Green Chemistry is based on a set of principles that when used in the design, development and implementation of chemical products and processes, enables scientists to protect and benefit the economy, people and the planet.

Green Chemistry uses renewable, biodegradable materials which do not persist in the environment.

Green Chemistry is using catalysis and biocatalysis to improve efficiency and conduct reactions at low or ambient temperatures.

Green Chemistry is a proven systems approach.

Green Chemistry reduces the use and generation of hazardous substances.

Green Chemistry offers a strategic pathway to build a sustainable future.

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To catalyze and enable the implementation of green chemistry and engineering throughout the global chemical enterprise