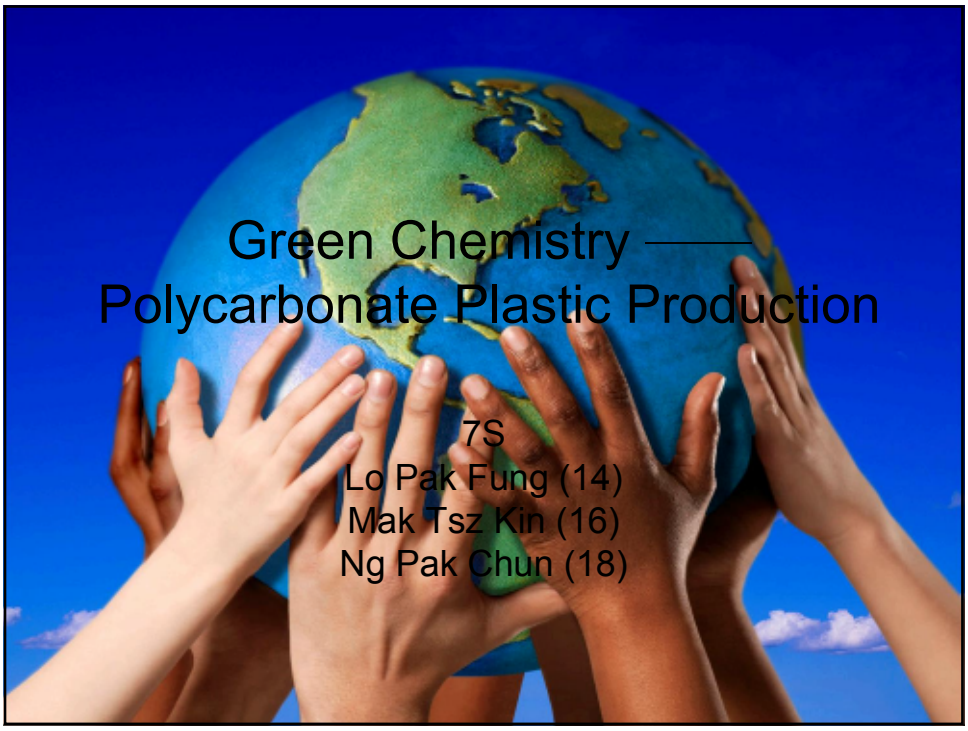


# Green Chemistry ——
# Polycarbonate Plastic Production

7S
Lo Pak Fung (14)
Mak Tsz Kin (16)
Ng Pak Chun (18)

## Content

- Properties and uses of polycarbonate
- Traditional method
- Greener method
- Comparison of 2 methods
- Principles of green chemistry In this process

# Properties of polycarbonate

- Do not conduct electricity
- high heat resistance
- flame retardant
- Durable
- Strong
- usable in a wider temperature range
- highly transparent
- easier to mould

# Electronic components : dielectric , electrical and telecommunications hardware

## Construction materials : sound walls

## Data storage : Blu-ray Discs

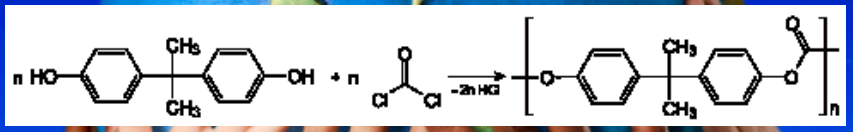
## Automotive, aircraft, and security components : bullet-proof "glass

## Niche applications : sunglass

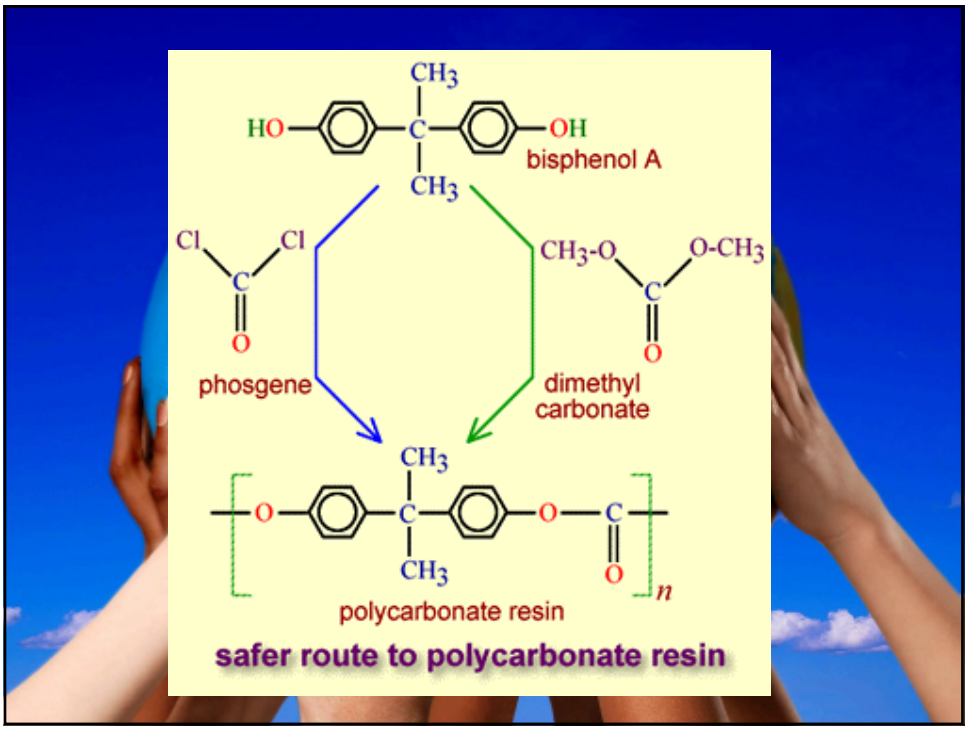
# Medical applications

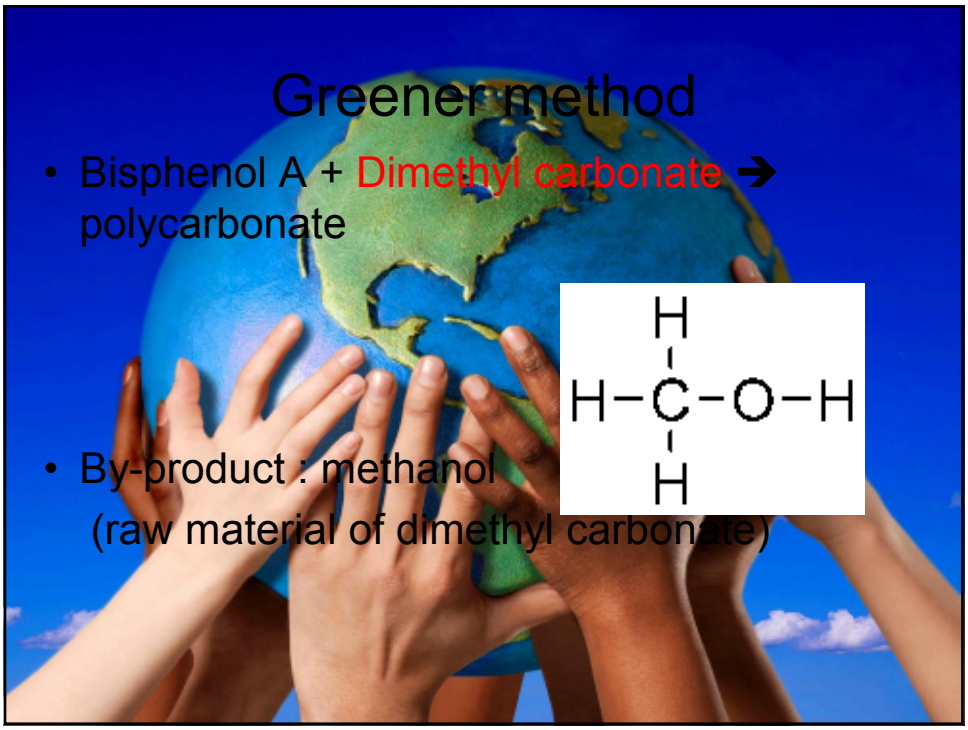

# Traditional method

- Bisphenol A + Phosgene → Polycarbonate




- Condition : addition of sodium hydroxide ( NaOH )
- By-product : hydrochloric acid ( HCl )


HO
OH
bisphenol A
Cl
Cl
phosgene
CH3-O
O-CH3
dimethyl carbonate
polycarbonate resin
safer route to polycarbonate resin


Greener method
• Bisphenol A + Dimethyl carbonate ➔ polycarbonate
• By-product : methanol
(raw material of dimethyl carbonate)

# Production of dimethyl carbonate

- carbon monoxide + methanol + oxygen → dimethyl carbonate and water

# Comparison of 2 methods

| Using phosgene | Using dimethyl carbonate |
|---|---|
| Dangerous reagent | Harmless reagent |
| Use of solvent | No solvent |
| Waste water treatment | No waste water |
| NaOH consumption | The base is catalytic |
| Exothermic | Slightly or not exothermic |
| high vapour density | Less dense |
| not easily disperse | Easier to disperse |
| Non-biodegradable | biodegradable |
| gas at r.t.p. ( difficult to handle ) | Liquid at r.t.p. ( easy to handle ) |

# 1. Prevention (prevent waste)

- Traditional method :

  Production of phosgene produce $CCl_4$ as by-product which is undesirable

- Greener method :

  the by-product ( methanol ) can be reused to make dimethyl carbonate

# 2. Atom economy (minimize by-product)

Comparison between formula mass of by-products :

- Traditional method

  %AE = 290.7 / ( 98.92+228.29 ) x 100% = 88.8%

- Greener method

  %AE = 290.7 / ( 90.08+228.29 ) x 100% = 91.3%

- Greener method has higher %AE.

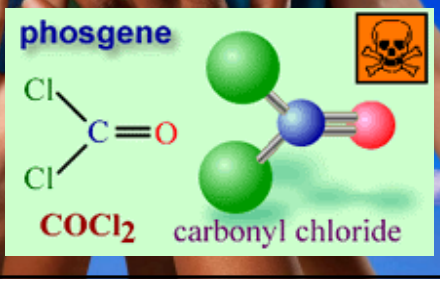
## 3. Less hazardous synthesis (Little or no toxicity)

- Traditional method :
  HCl is strong acid and it is corrosive
- Greener method :
  Methanol is relatively harmless

## 4. Designing safer chemicals

Traditional method :

- phosgene is highly toxic
- used as a chemical weapon in the WWI
  ( responsible for about 80% of chemical fatalities)




5.Safer auxiliary substances(e.g. solvents, separation agents, etc.)
• Traditional method :
Required organic solvent which is carcinogenic
• Greener method :
Use water as solvent


6.Energy efficiency
• Traditional method :
Require higher temperature to trigger off the reaction
• Greener method :
Need lower temperature to activate the reaction

## 7. Use of renewable resources

- Traditional method :

  $Cl_2$ is non-renewable which is the raw material of phosgene

- Greener method :

  Methanol, CO and $O_2$ are renewable which are raw materials of dimethyl carbonate

## 8. Reducing derivatives (fewer steps of reaction)

- Traditional method :

  The purification of CO used in producing phosgene is more complicated and it is difficult to separate the product from by-product

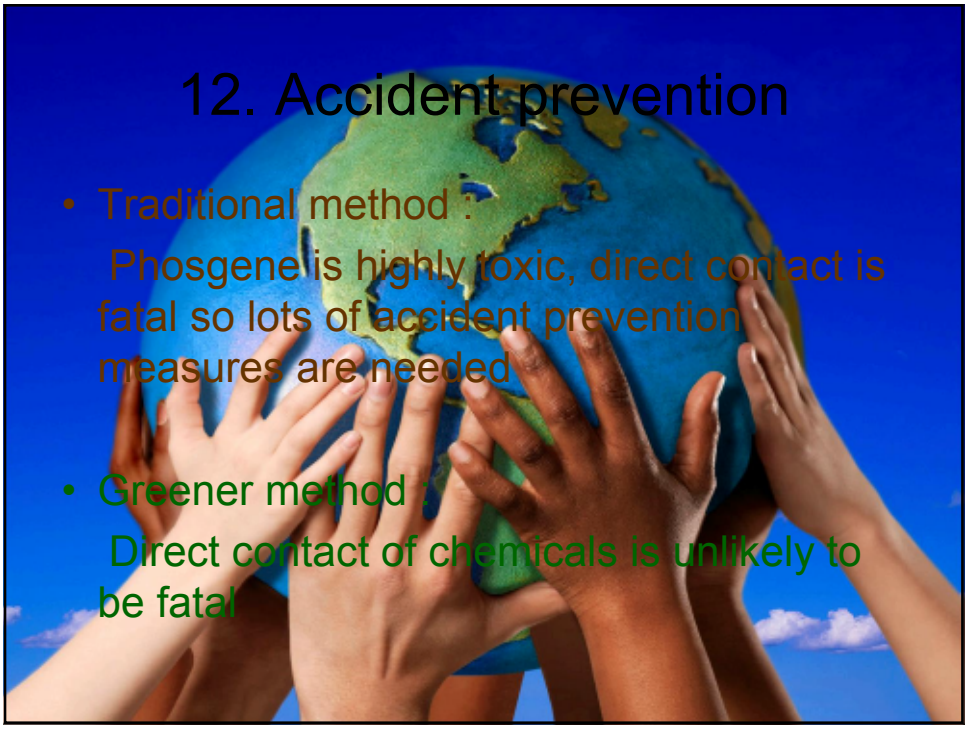
- Greener method :

  Purification is not required and it is easy to separate the product from methanol ( low boiling point )


9.Catalysis
• Traditional method :
Activated carbon is required and it is difficult to produce
• Green method :
Copper chloride with 5% KCl additive is needed to produce dimethyl carbonate


10. Design for degradation (decomposition)
• Traditional method :
The excess chemicals are not degradable
• Greener method :
The remaining dimethyl carbonate is biodegradable


11.Use real-time analysis for pollution prevention
• Traditional method :
Phosgene is a colourless gas and has unnoticeable odour, leakage is difficult to be detected
• Greener method :
All chemicals are liquids, leakage is relatively easy to be detected instantly


12. Accident prevention
• Traditional method :
Phosgene is highly toxic, direct contact is fatal so lots of accident prevention measures are needed
• Greener method :
Direct contact of chemicals is unlikely to be fatal


The END