What is Chemical & Biochemical Engineering?

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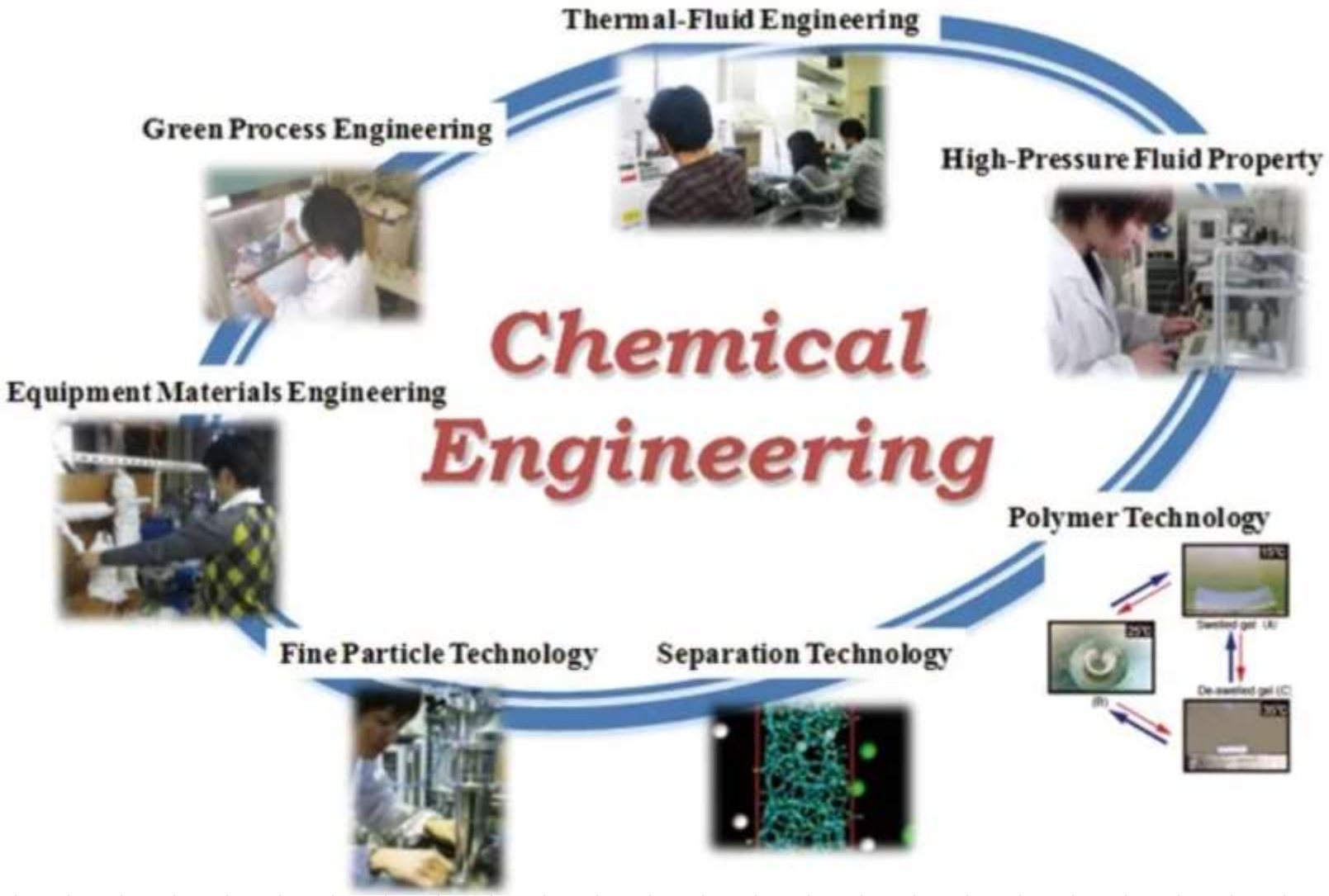
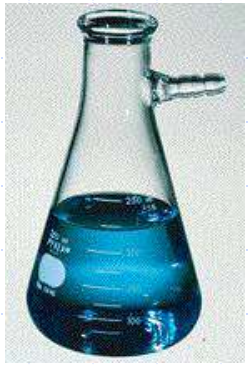
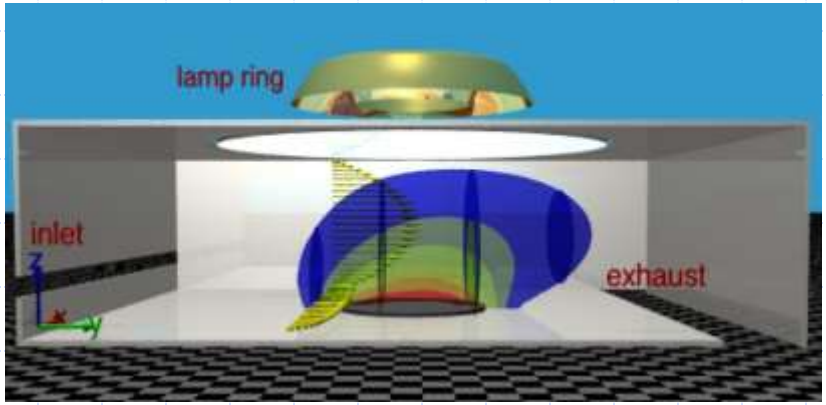
Chemical engineering

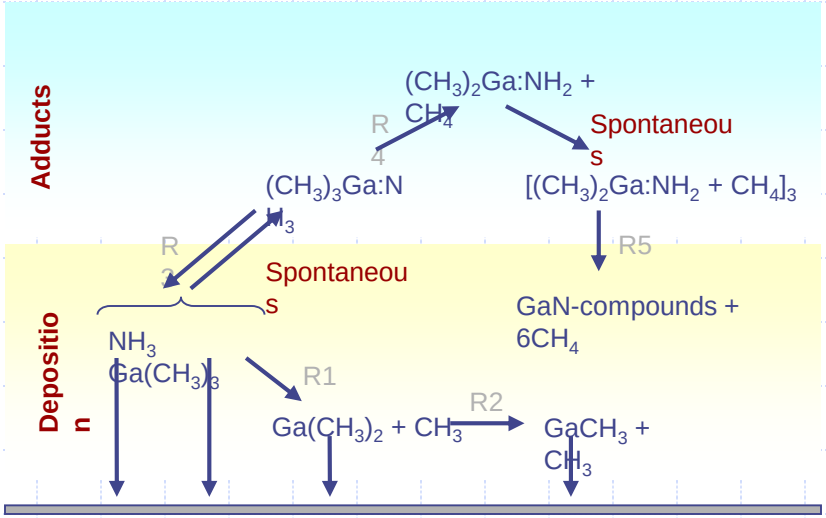


What is Chemical & Biochemical Engineering?



Chemical Engineering: manipulating the interplay between transport, thermodynamics, and reaction mechanisms of chemical species.





What is Chemical & Biochemical Engineering?

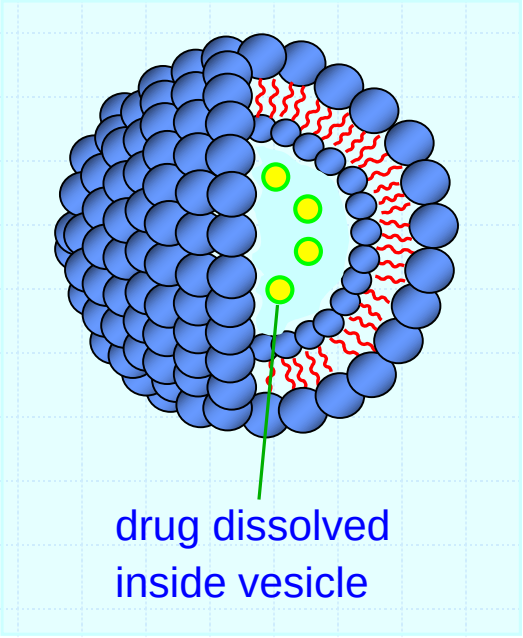
- Includes engineering of biological processes
  - Genetic modification of host organisms (reactors)
  - Downstream processing of products (extract and purify)
  - Products include biopharmaceuticals, diagnostics, foods, chemical intermediates

Bioprocess Scale-Up Facility

What is Chemical & Biochemical Engineering?

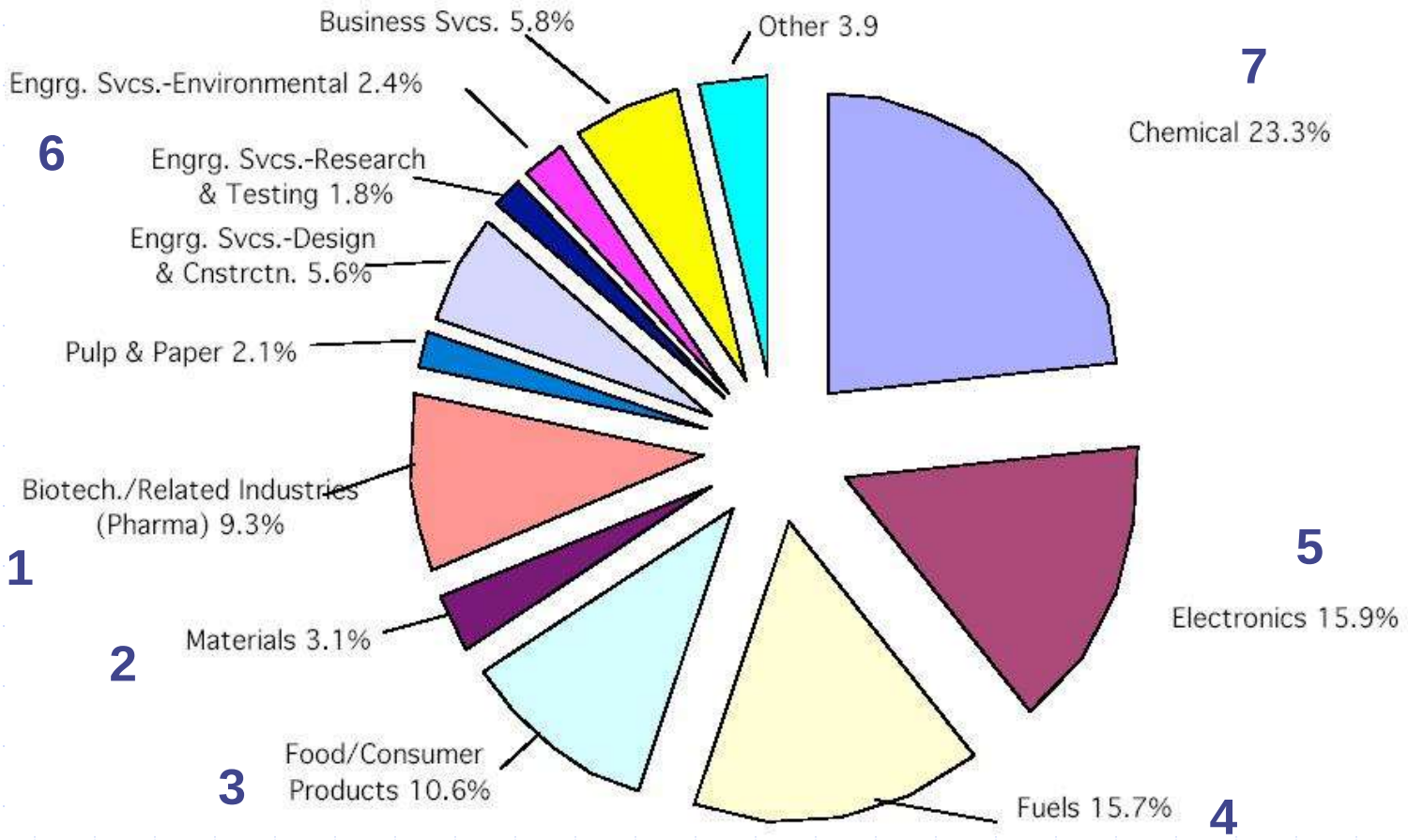
- Chemical product engineering
  - Engineer specialized and functional chemical products
  - Chemical engineering at the micro and nanoscale

Complex fluids with tunable properties



What do Chemical & Biochemical Engineers do?

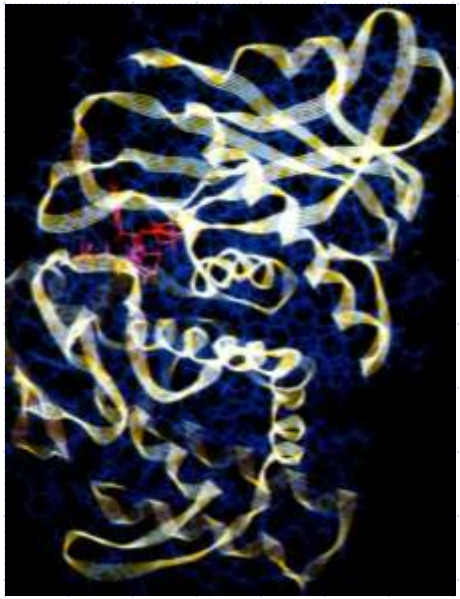
- Source: AIChE



What do Chemical & Biochemical Engineers do?

Biochemical and Biomedical Engineering

Biopharmaceuticals, enzyme production
Artificial organs
Tissue engineering
Metabolic engineering
Genomics and proteomics
Fermentation technology
Waste remediation
Biomedical materials



What do Chemical & Biochemical Engineers do?

Energy and Fuels

Petroleum refining
Natural gas
Fuel cells
Alternative fuel sources
Clean power generation

Food Processing

New food products
Food additives
Optimization of flavor, texture
Packaging
Shelf life

What do Chemical & Biochemical Engineers do?

Electronics

Thin film and bulk processing
Semiconductor materials development
Waste treatment
Equipment design
Fab water supply
Nano-scale technology

What do Chemical & Biochemical Engineers do?

Environmental, Safety, Health, Government

Waste minimization
Transportation safety
Plant security
CPI intellectual property
Graduate school
Medical school
Education
Finance
Government

What have Chemical & Biochemical Engineers done?

Commodity and specialty chemical processing

Agricultural chemicals
Industrial gases
Paints, pigments, and inks
Petrochemicals
Plastics, composite
Paper
Soaps and cosmetics
Synthetic fibers, films, and textiles

Chemical Process Design and Construction

Process unit and plant design
Upgrades and retrofits
Plant-wide control
Information technology
Project management

What WILL Chemical & Biochemical Engineers do?

- Big picture problems, grand challenges
- In the news…
  - Fuel supply - alternative fuels, escalating demand, rapid fluctuations in availability due to natural/political disasters
  - Pandemics - lack of vaccine production capabilities
  - Terrorism - chem/bio sensing capabilities and lack of remediation methods for major events

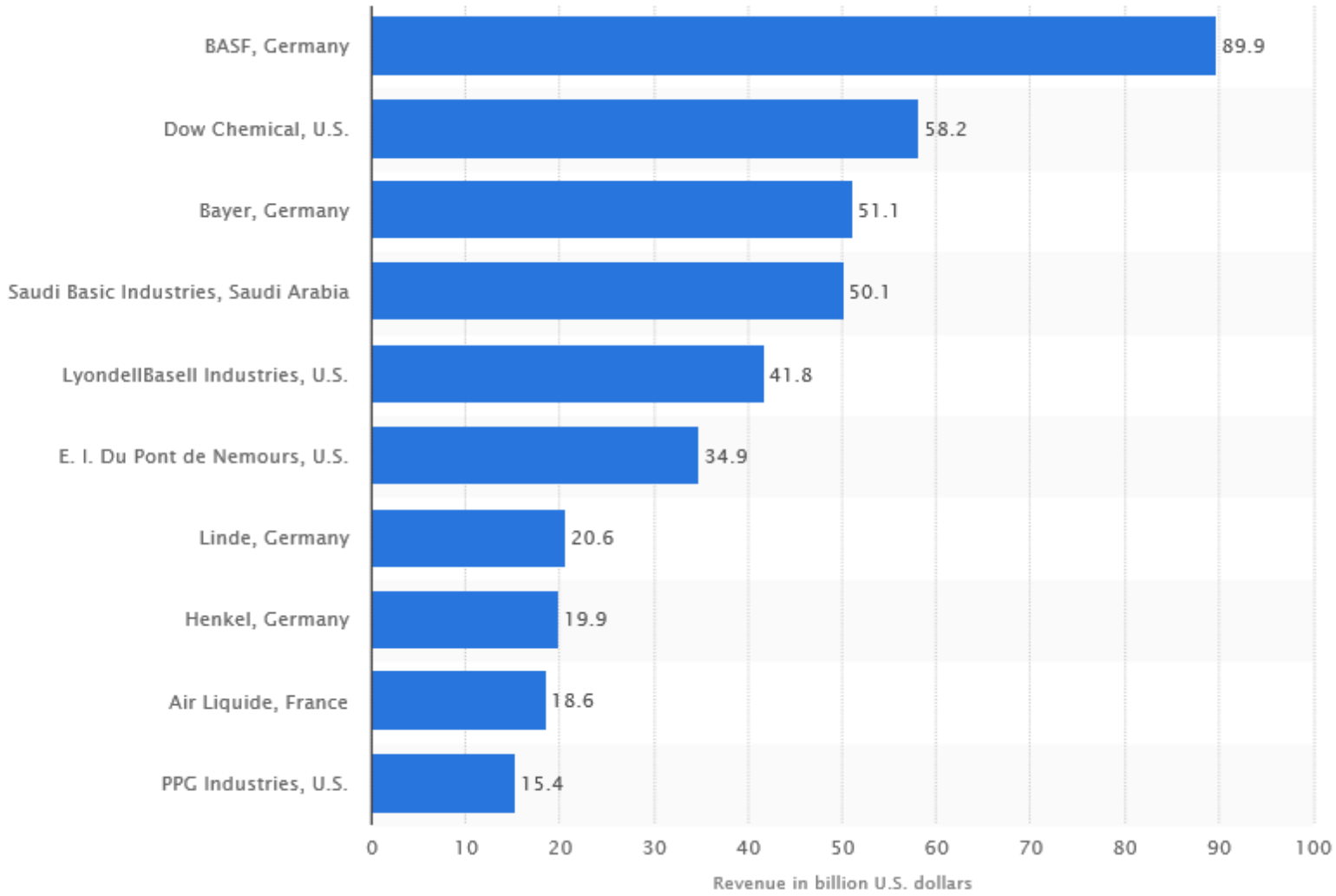
Chemical & Biochemical Engineering: some applications

Chemical production in US

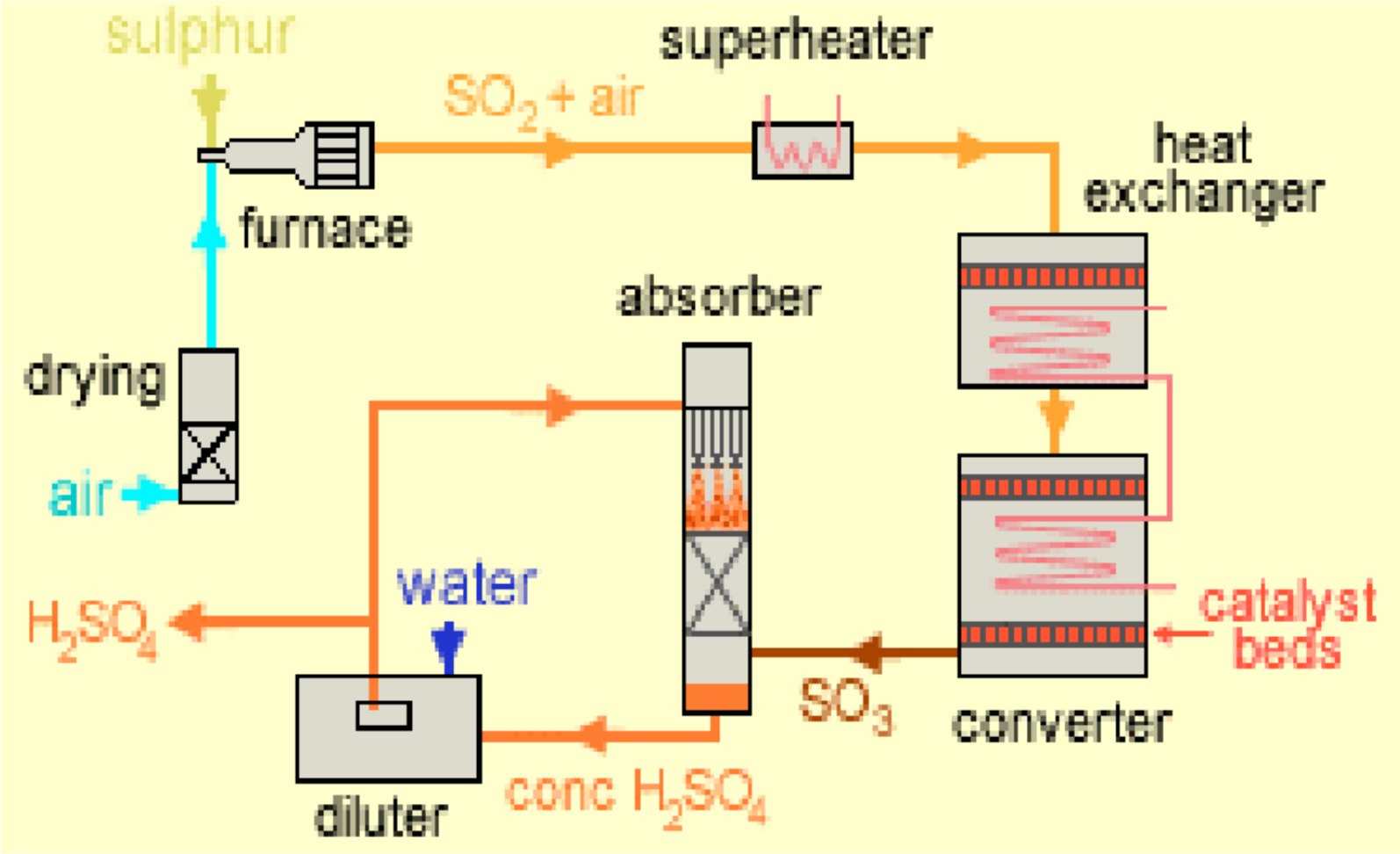
(in milions of tons)

1. sulfuric acid 35.954
2. nitrogen 30.543
3. ethylene 25.682
4. oxygen 25.568
5. propylene 15.345
6. chlorine 12.166
7. ethylene dichloride 12.163
8. phosphoric acid 11.463
9. ammonia 10.762
10. sodium hydroxide 9.508
11. benzene 7.675
12. nitric acid 6.703
13. ammonium nitrate 6.021
14. ethylbenzene 5.779
15. urea 5.755
16. styrene 5.394
17. hydrochloric acid 5.012
18. ethylene oxide 3.772
19. cumene 3.736
20. ammonium sulfate 2.643

10 largest production industries in the world: 2015 ranking

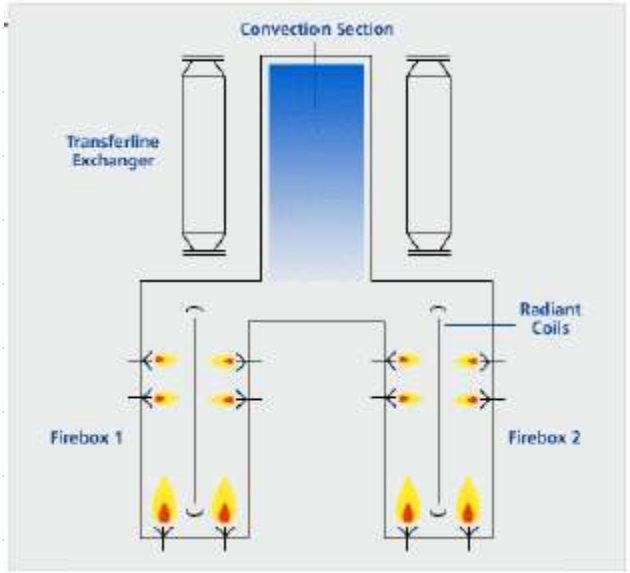


Production of sulfuric acid



Production of ethylene

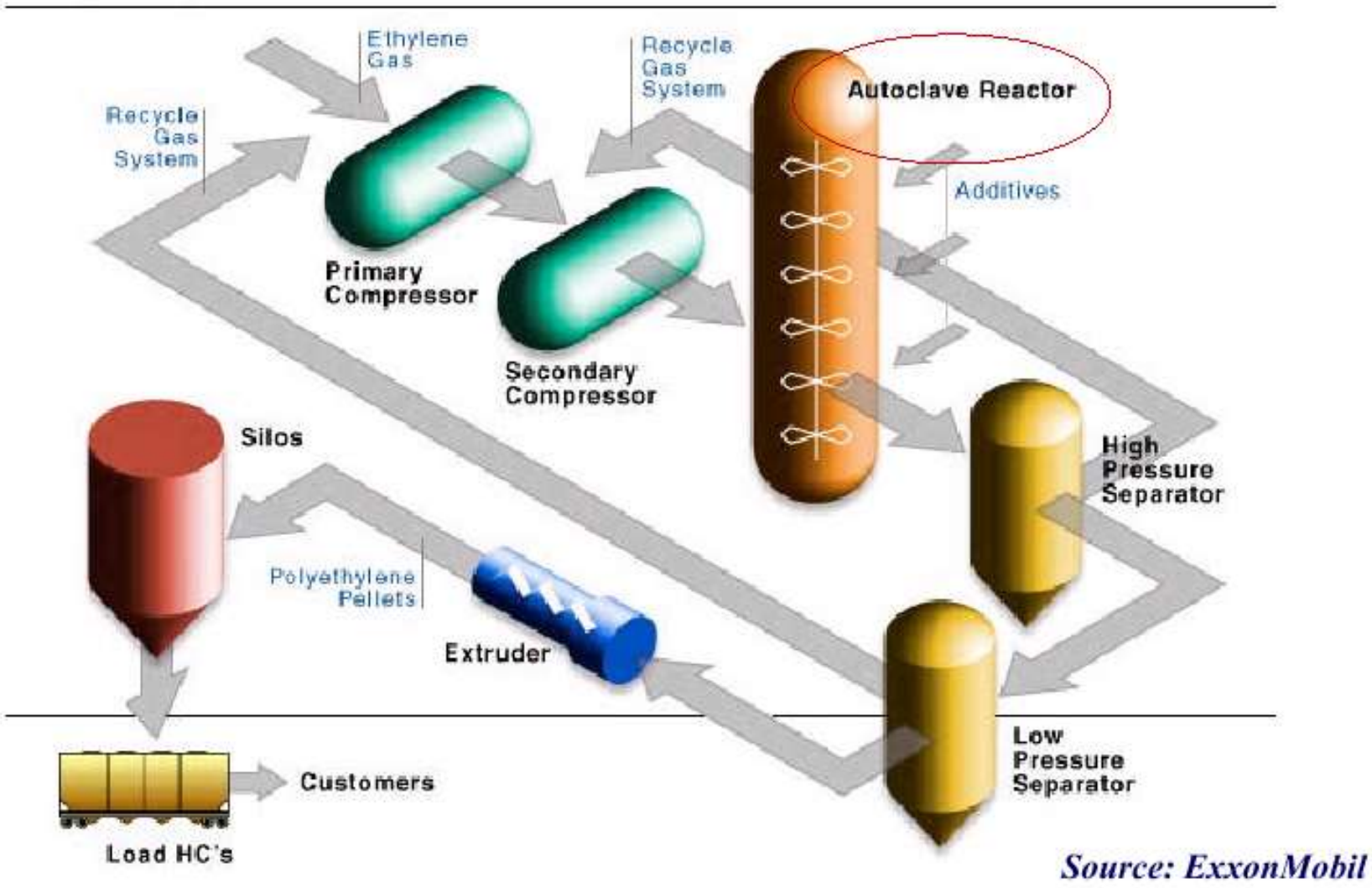
- Ethylene is used for the production of poli ethylene, probably the most popular plastic in the world
- NOVA Chemicals and Dow Chemical at Joffre
  - The largest productive capacity in the world
  - The largest ethylene plant in the world



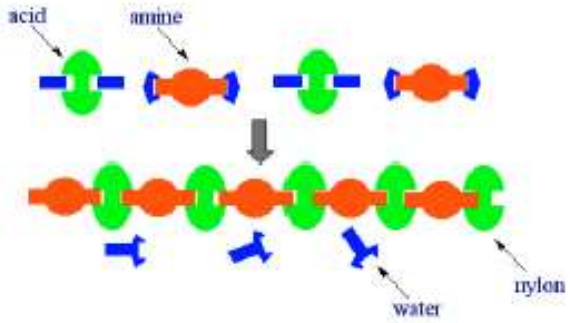
$$C_2H_6 \rightarrow C_2H_4 + H_2$$

High temperature tubular reactors

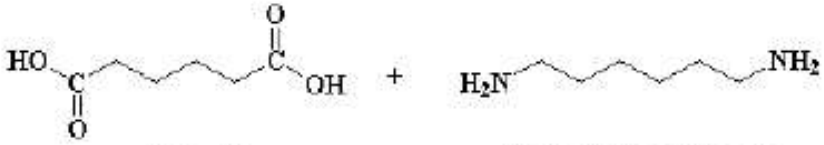
Production of low density poli ethylene



Production of Nylon 6,6

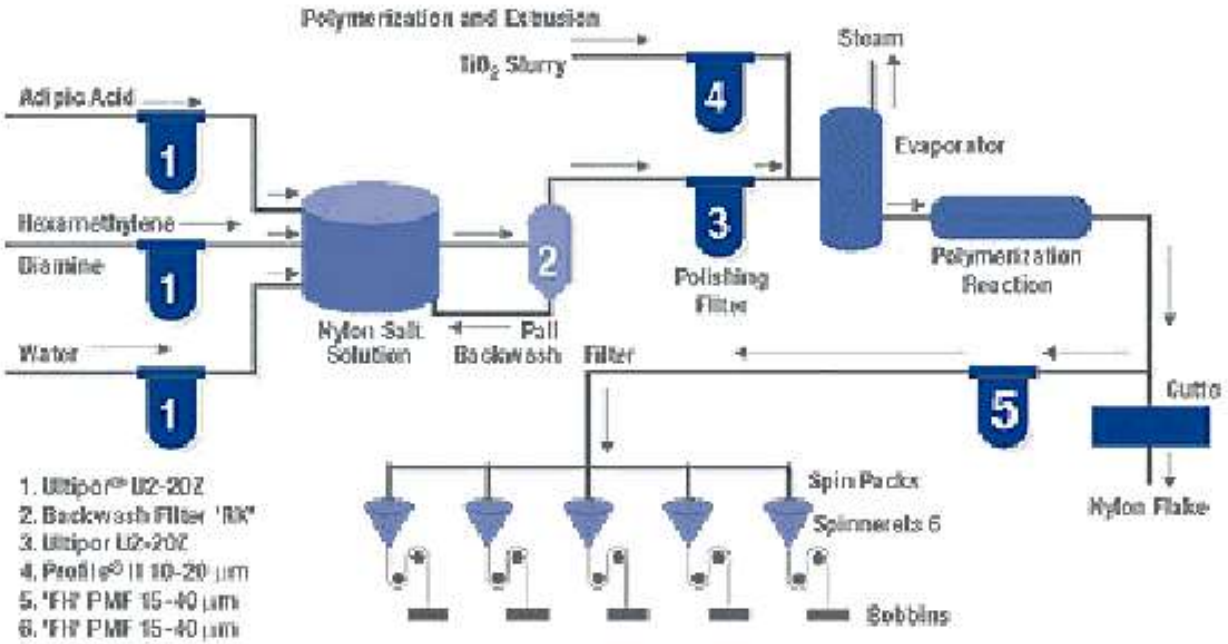


DuPont Canada, Kingston is a major producer of Nylon 6,6

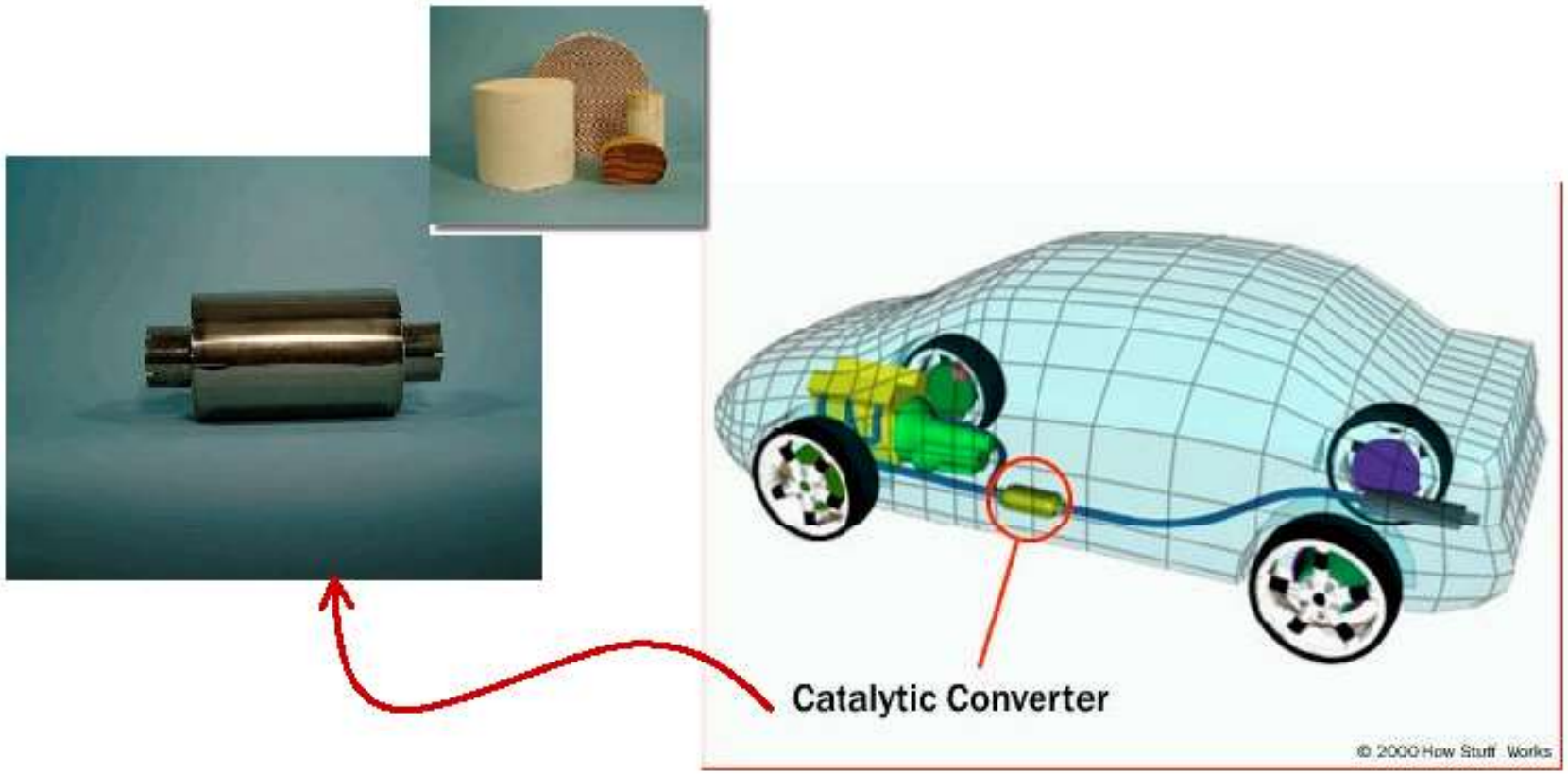


adipic acid **hexamethylene diamine**

ı 6,6

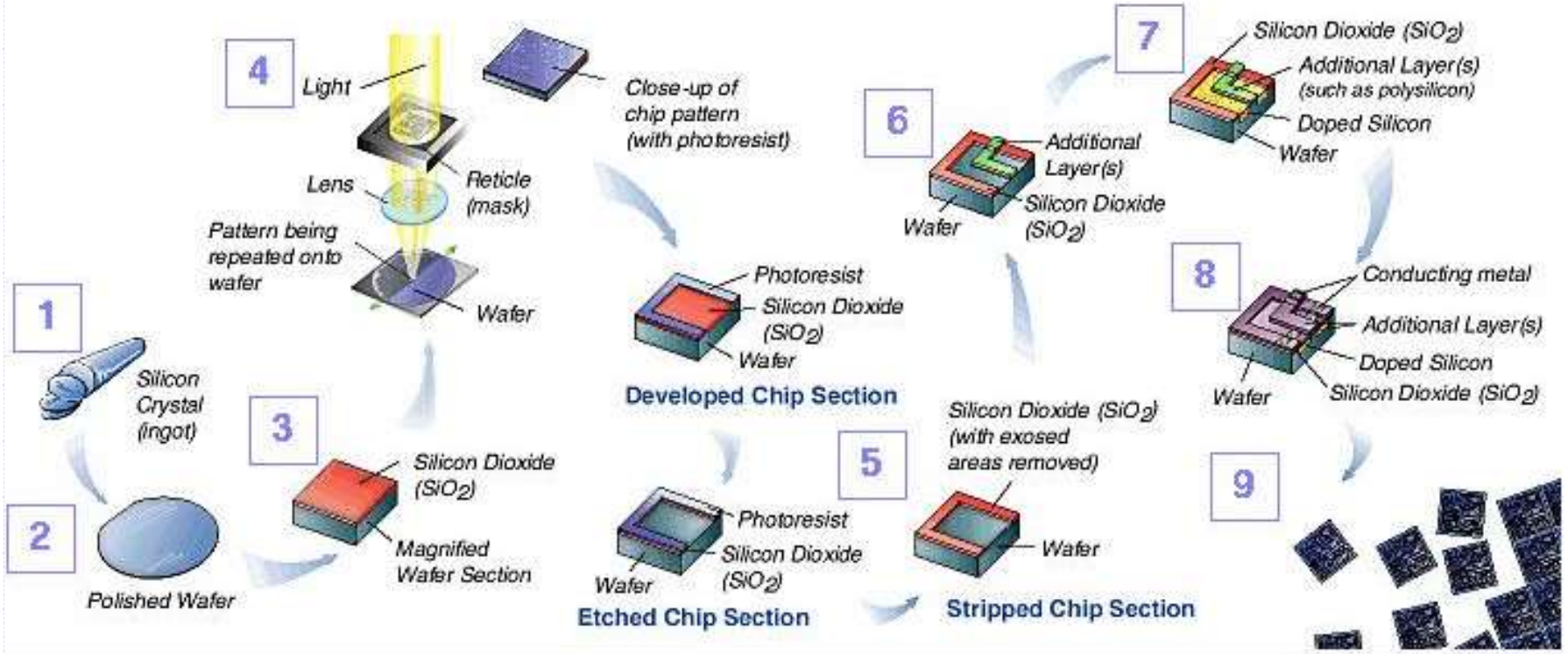


Catalytic reactors in automotive industry

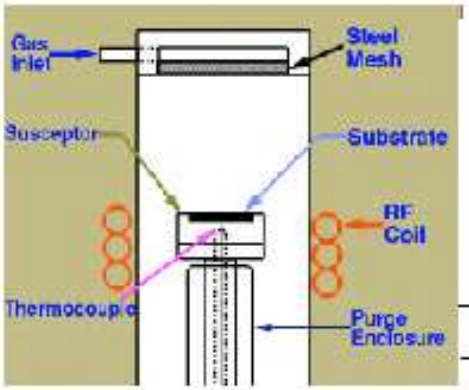


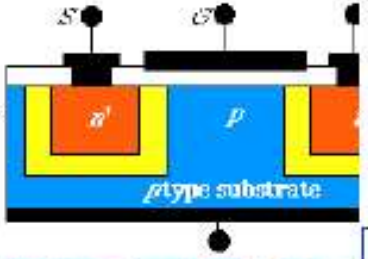
Microelectronic devices

- CCRE for the fabrication of devices for microelectronics
  - CVD (chemical vapor deposition SiO2)
  - Boron doping or ion-implementation (change in conductivity)

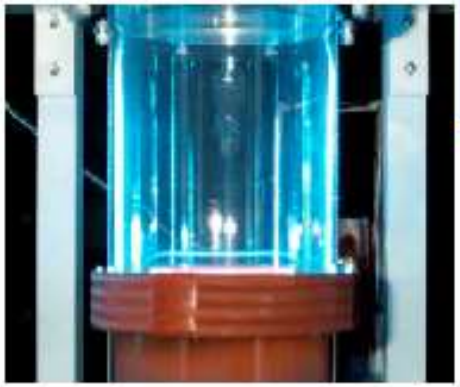


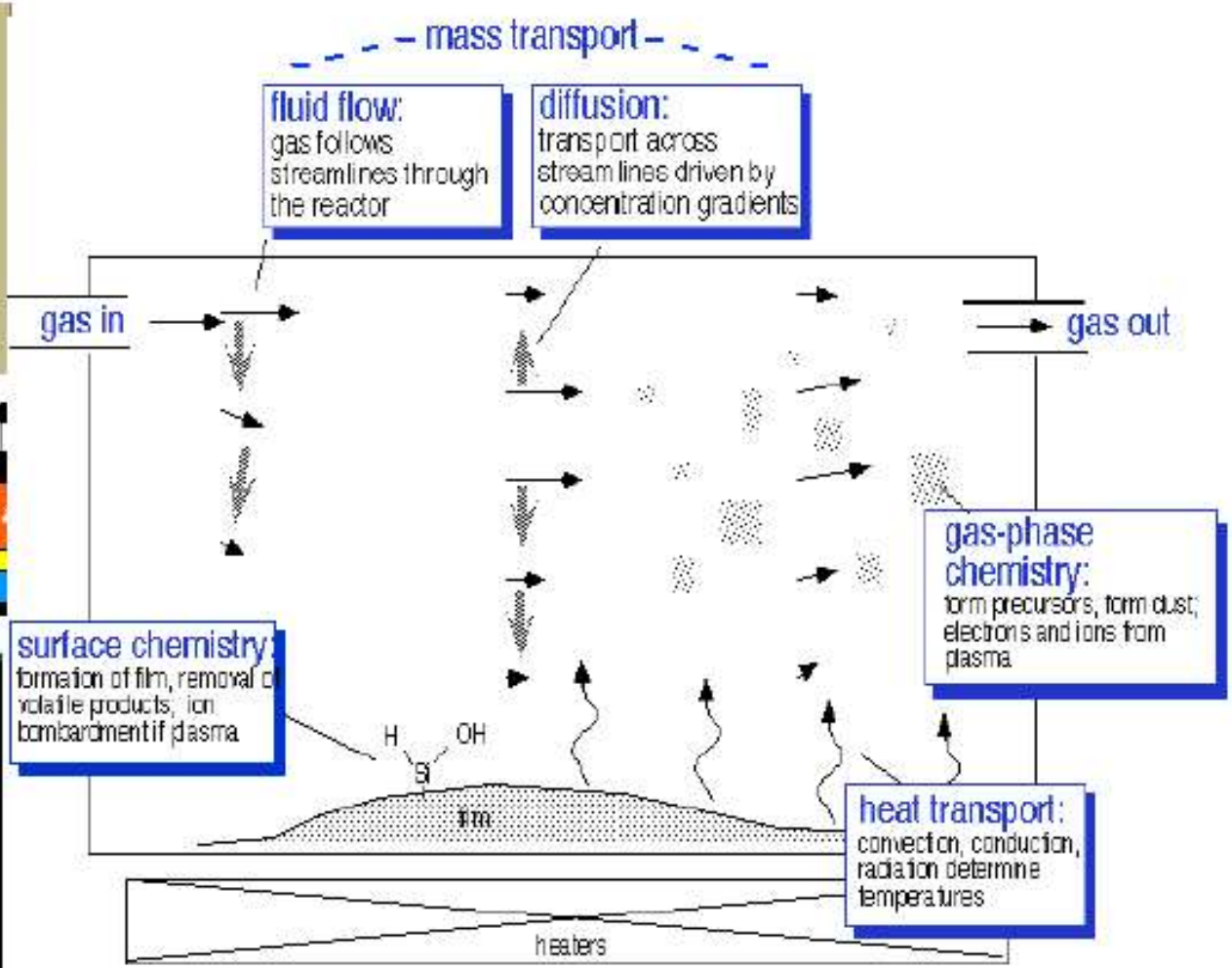
CVD for microelectronic industry



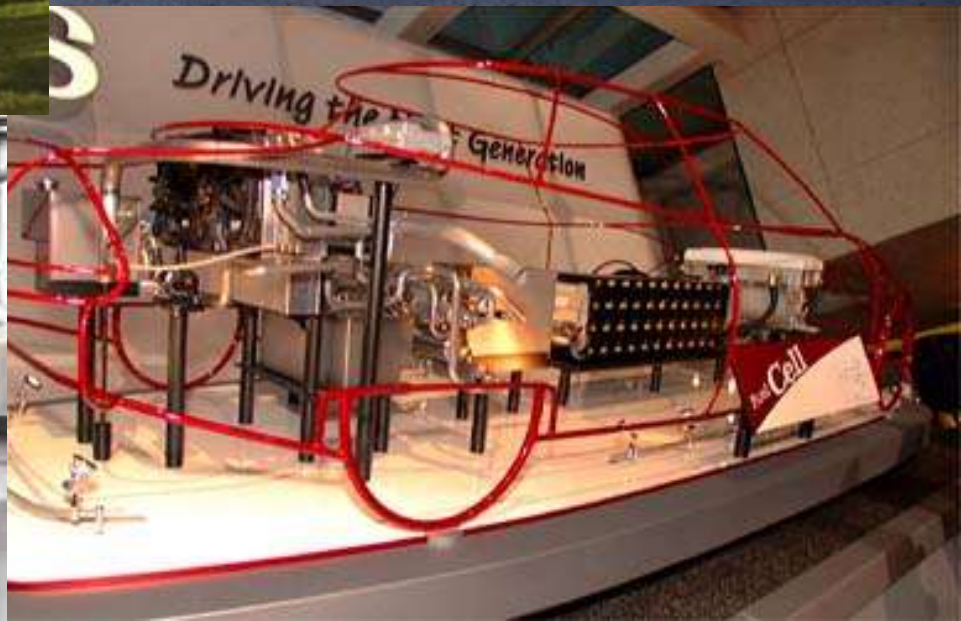


Electronic Devices





Fuel cells: Power station & Automotive



Fuel Cells

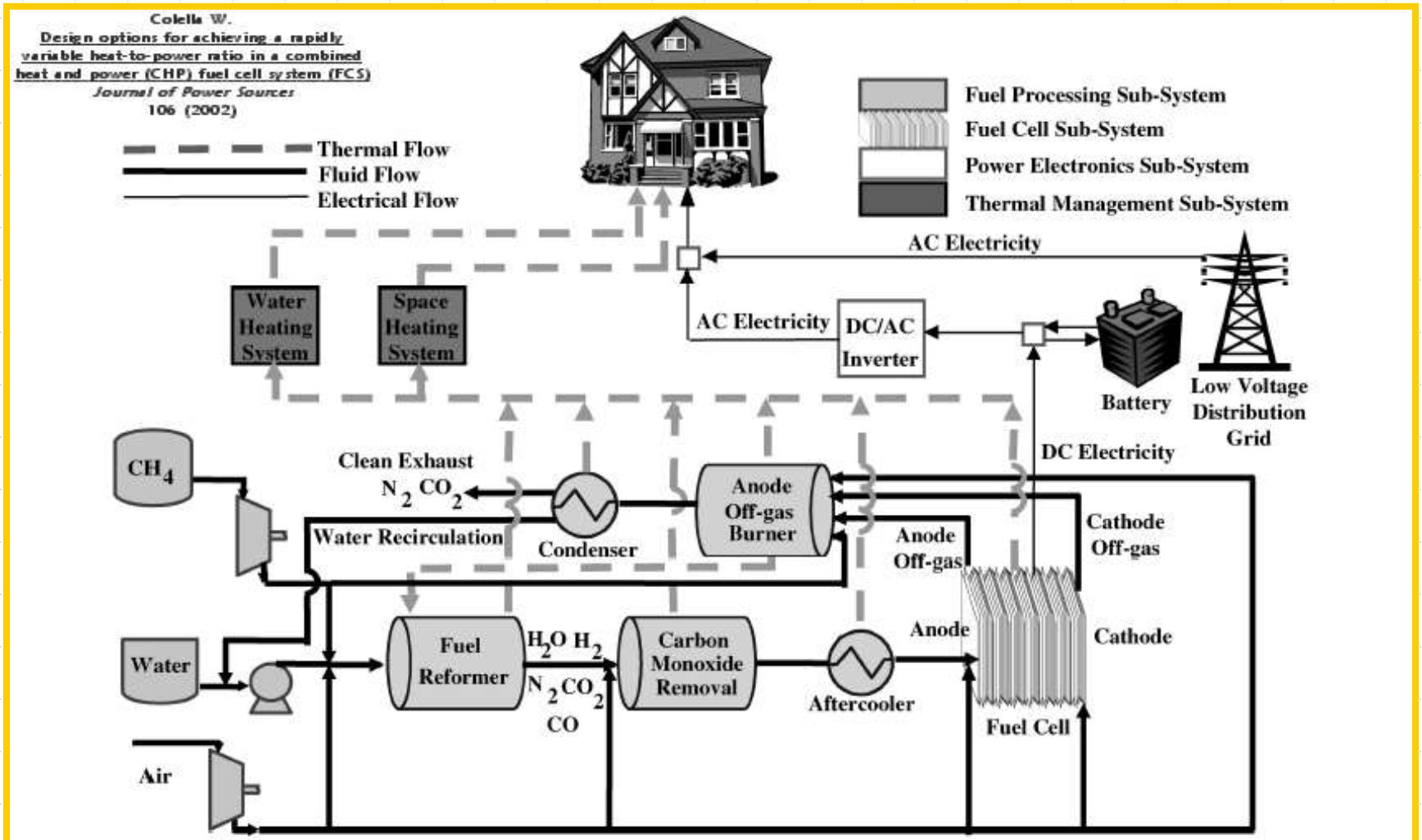


Fig. 3. Shows a schematic diagram of one type of combined heat and power (CHP) fuel cell system (FCS) using a proton exchange membrane (PEM) fuel cell and a fuel processing system for the delivery of hydrogen fuel. The thick solid line represents gas flow of products and reactants; the thin solid line represents electricity flow; and the thick dashed line indicates heat flow.