

Toray Proprietary

TORAY

Innovation by Chemistry

Innovation in Carbon Fiber Business

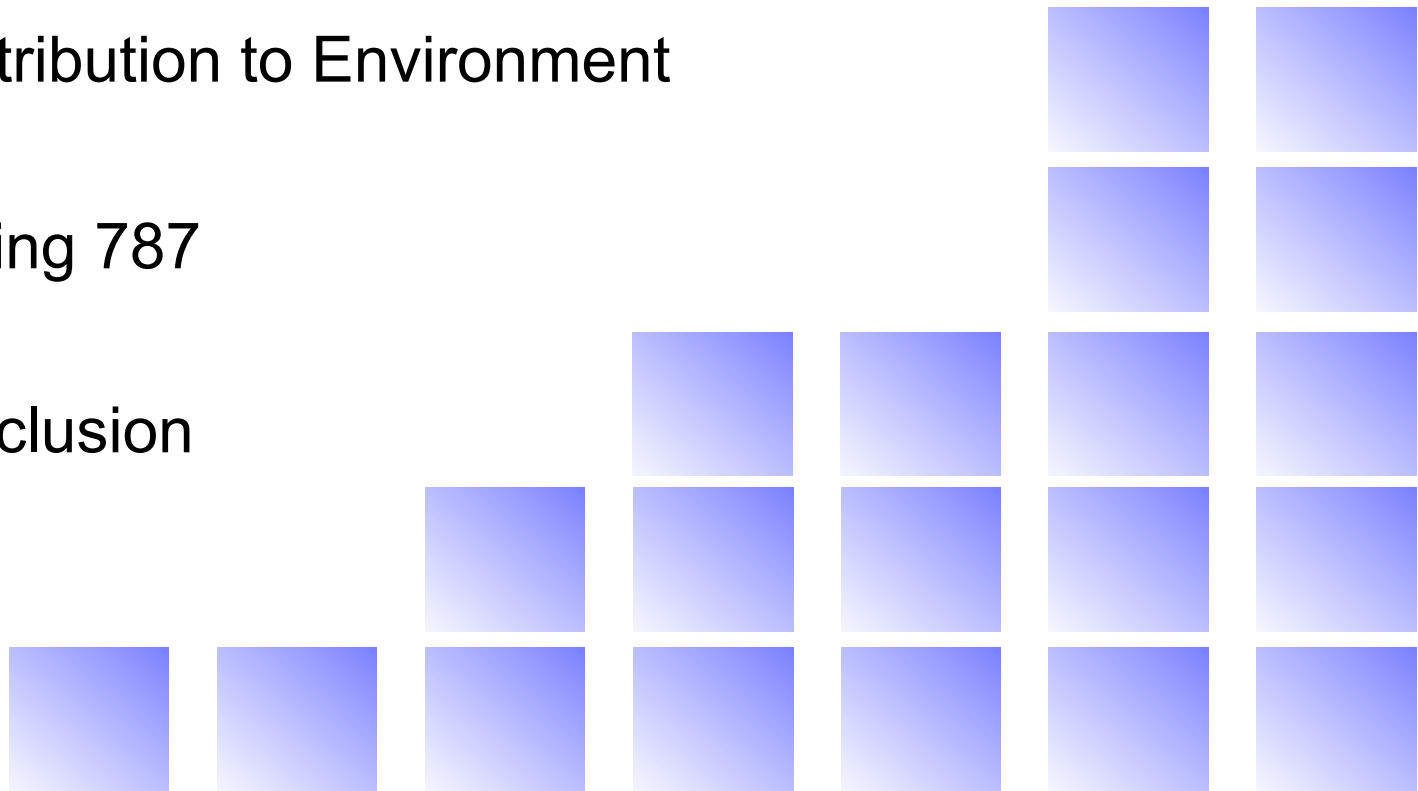
November 1, 2012

Toshiyuki Kondo

Toray Composites (America), Inc.

Agenda

1. Outline of Toray Group
2. Carbon Fiber & Composites
3. Contribution to Environment
4. Boeing 787
5. Conclusion



Outline of Toray Group

- 1. Establishment : 1926
- 2. Capital : JPY 148 Billion
- 3. Group Sales : JPY 1,530 Billion
- 4. Number of Subsidiaries : 240
- 5. Number of Employees : 38,000

Foundation
Businesses

Fibers & Textiles

Plastics & Chemicals

Strategically
Expanding
Businesses

IT-Related Products

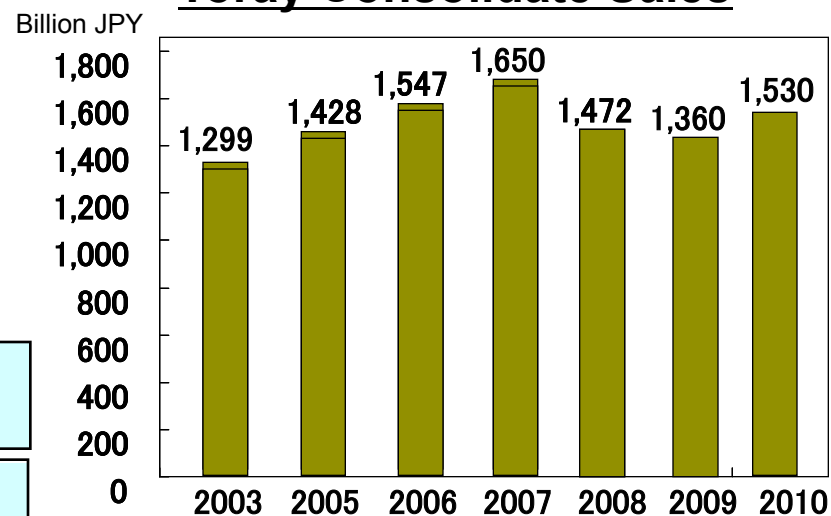
Carbon Fiber & Composite Materials

Intensively
Developing
and
Expanding
Business

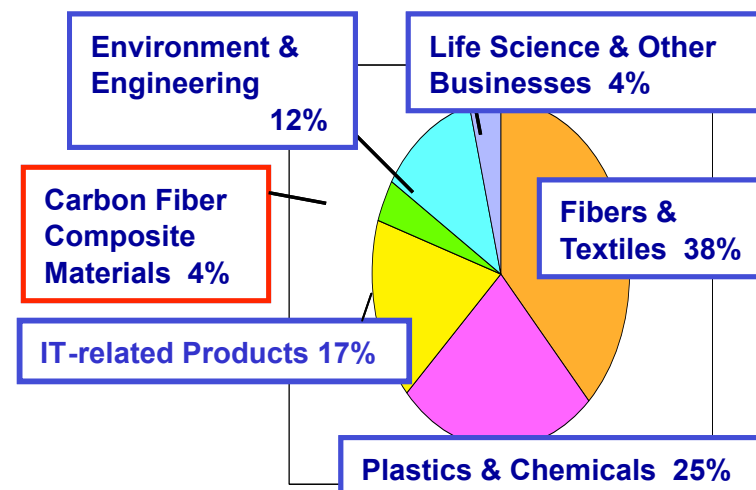
Environment & Engineering

Life Science & others

Toray Consolidate Sales



Sales by segment in FY2010



Toray's Major Products

Fibers and Textiles



Snowboard clothing



Carbon Fiber Composite Materials

IT-related Products



Color Filters

Plastics & Chemicals



Boeing 787



Life Science

Contact lens



Polyester film



Compostable Bag
bio-degradable

Environment & Engineering

Medical products



Interferon

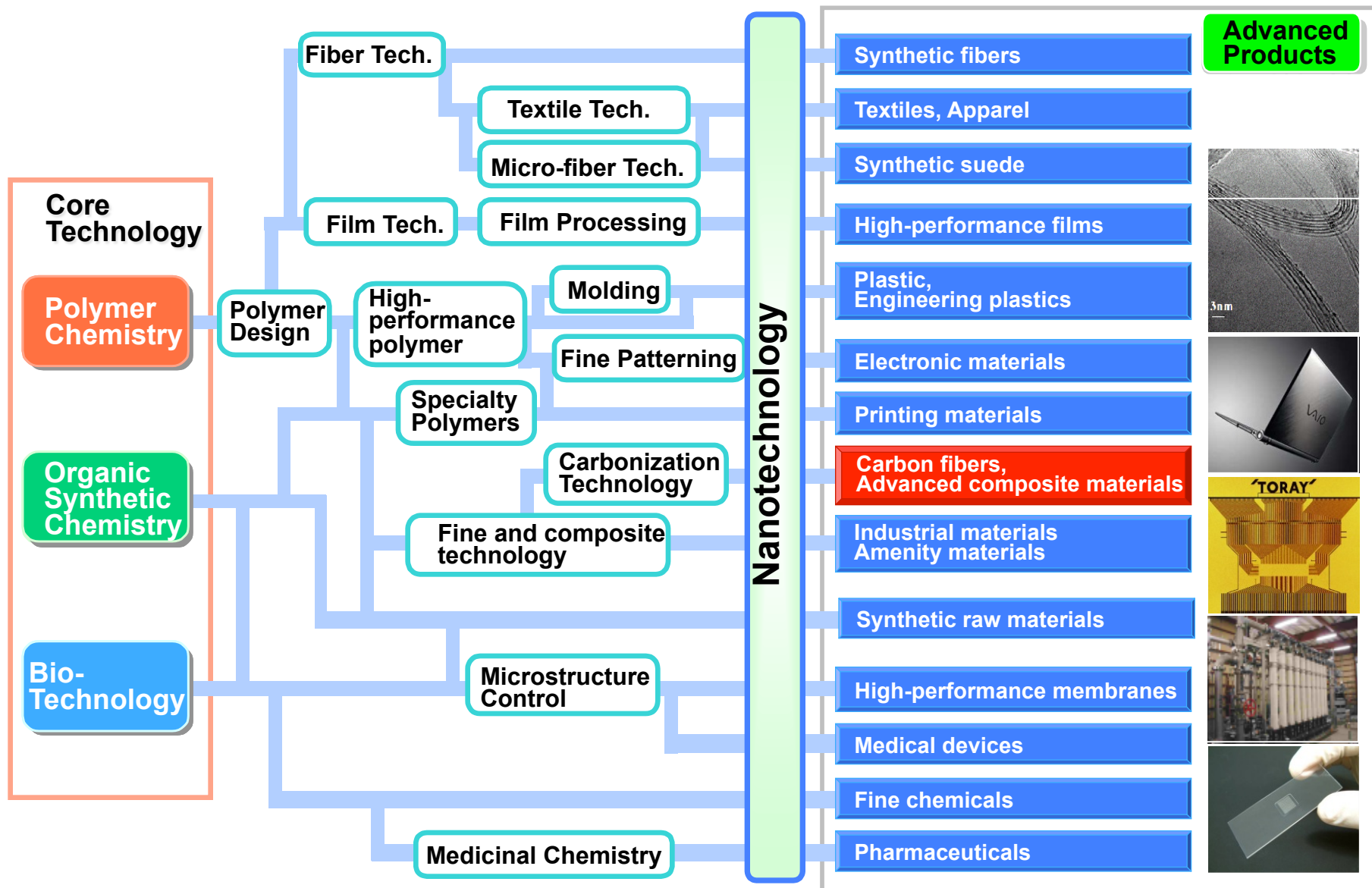


Cleaning Cloth



Home Water Purifiers

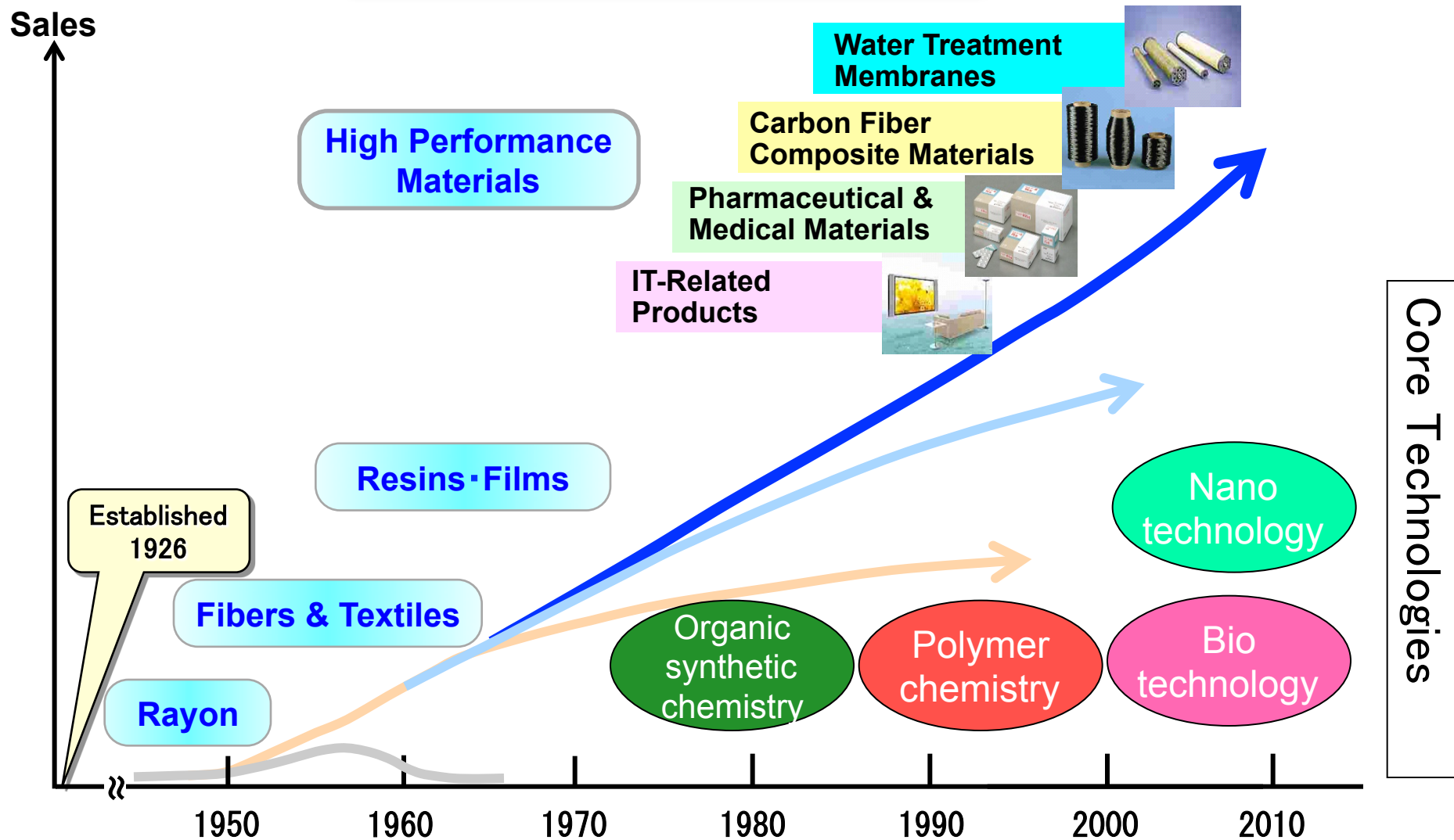
Toray's Technology Fields & Products



Toray's Business Fields

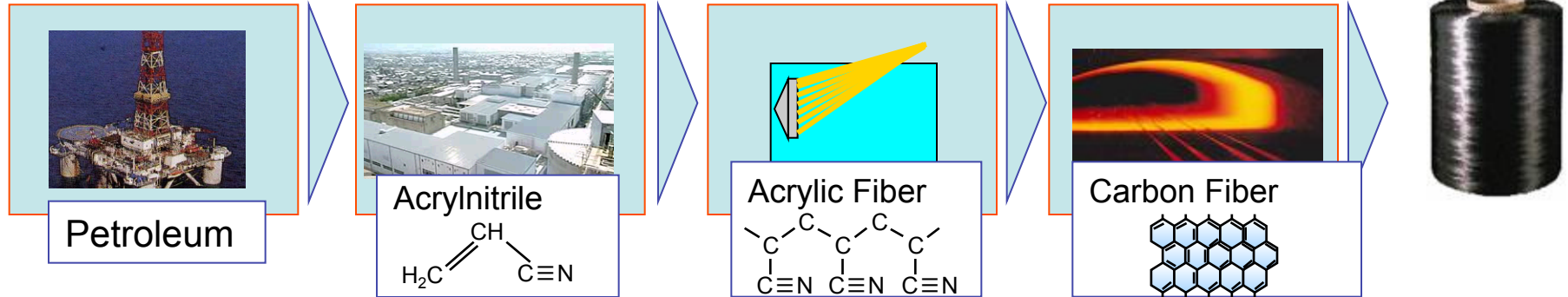
**Toward top global company
in advanced materials**

**Solutions for
Environmental issues**



Carbon Fiber

Carbon Fiber Production



Mechanical Performance

1. Light Weight

Specific Gravity
: 1/4 of steel

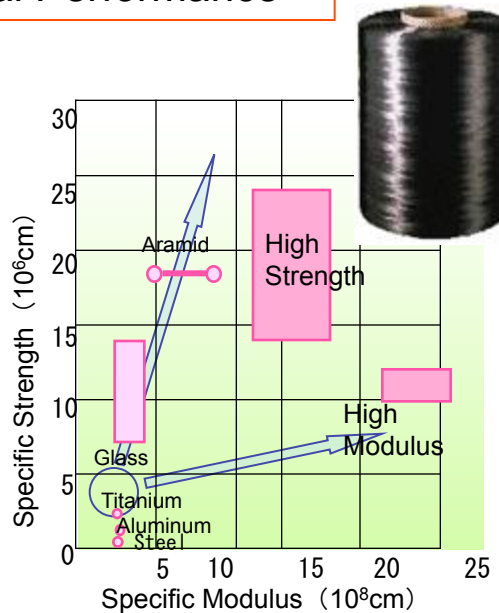
2. High Strength

Specific Tensile Strength
: 10 times of steel

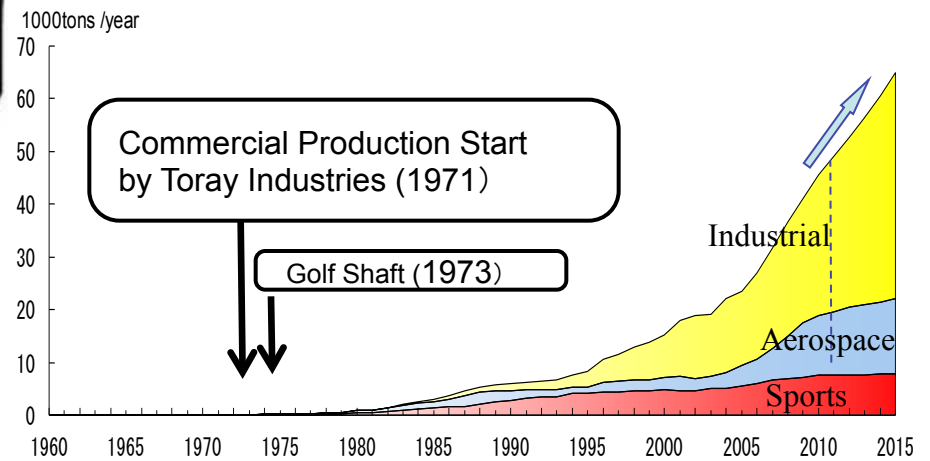
3. High Modulus

Specific Tensile Modulus
: 7 times of steel

4. Rust Free



Carbon Fiber Market



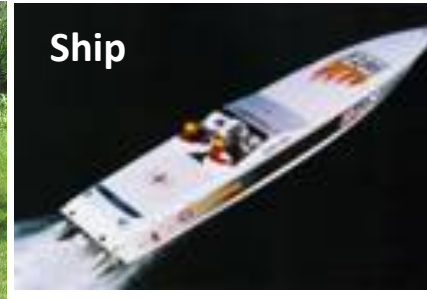
Carbon Fiber Composites - Advantage and Application -



Airplane Copyright Boeing



Electric Car



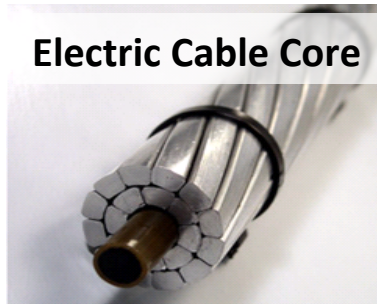
Ship



Bicycle

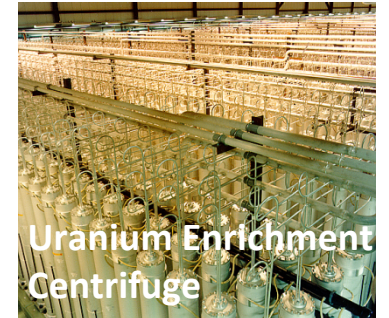


Offshore oil exploration



Electric Cable Core

- High Specific Tensile Strength
→ 10 times of steel
- High Specific Tensile Modulus
→ 7 times of steel
- Better Fatigue Resistance
→ Longer life
- High Electrical Conductivity
- Corrosion Free



Uranium Enrichment Centrifuge



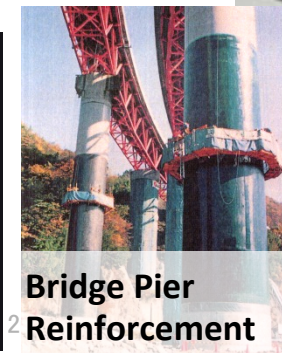
Fuel Cell Stack



CNG (Compressed natural Gas) Tank



Note PC Casing



Bridge Pier Reinforcement



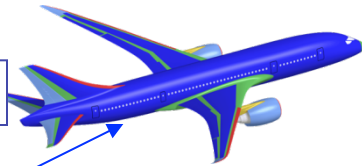
Windmill Blades

Contribution of Carbon Fibers to Global Warming

Reduction of CO2 Emission

Light Weight

Airplane



B787

CFRP (50% of Structure)

MRJ



Empenage; CFRP

Automobile



Structure CFRP



Next generation car; CFRP

Alternative Fuel

CNG Automobile



Light Weight CNG Tank With CFRP

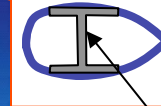
Generation of Clean Energy

High Efficiency

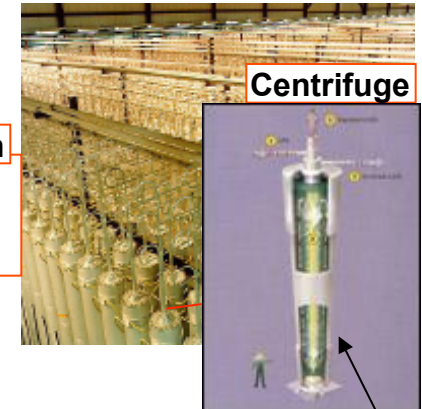


100m Blade in Diameter With CFRP

Cross Section



CFRP



Centrifuge

High Speed Rotator With CFRP

CFRP

Large Scall Windmill

Uranium Enrichment

Others

70 Mpa Tank with CFRP



Hydrogen Tank

CFRP

Electrode with CF



Fuel Cell

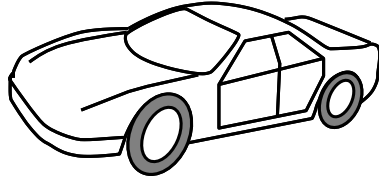
CFRP

(CFRP: Carbon Fiber Reinforced Plastics)

Carbon Fiber contributes to reduce CO2 emission during usage and to generate clean energies

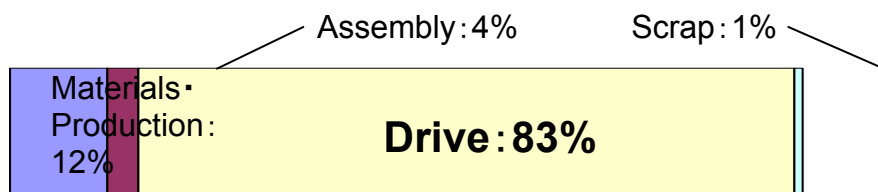
Conventional automobile and airplane in “JCMA Model”

Automobile



< Presupposition >

Type: Middle size, Gasoline engine,
4 door, FF (average weight: 1,380kg)
Mileage: 9.8km/l (average in Japan),
Lifetime: 10yrs; 9,400km/yr (ditto)
(Ref : JAMA)

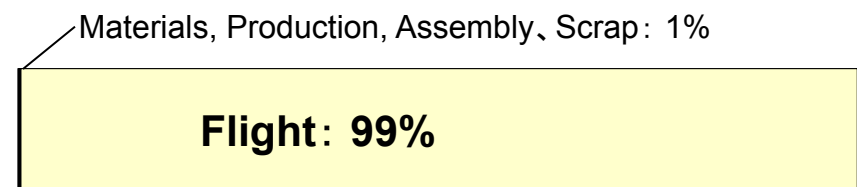


Airplane



<Presupposition>

Type: Middle size (B767; 280 seats)
Flight: Domestic line (Tokyo⇔Sapporo),
Lifetime: 10 yrs; 2,000 flights/yr
(Ref : ANA)

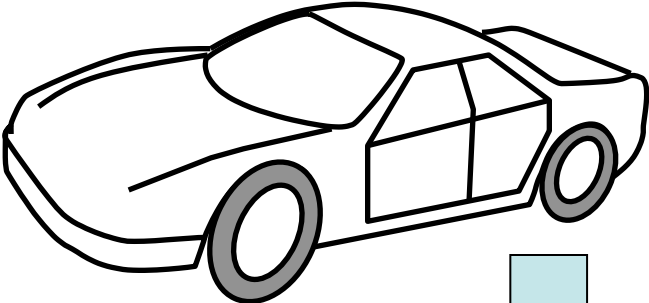


Most CO₂ is emitted during drives & flights
(Automobile : 83%、Airplane : 99%)

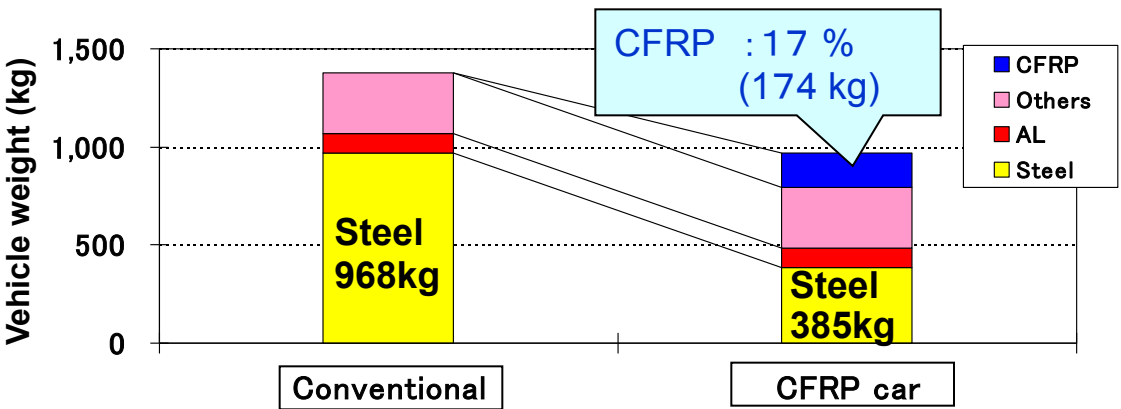
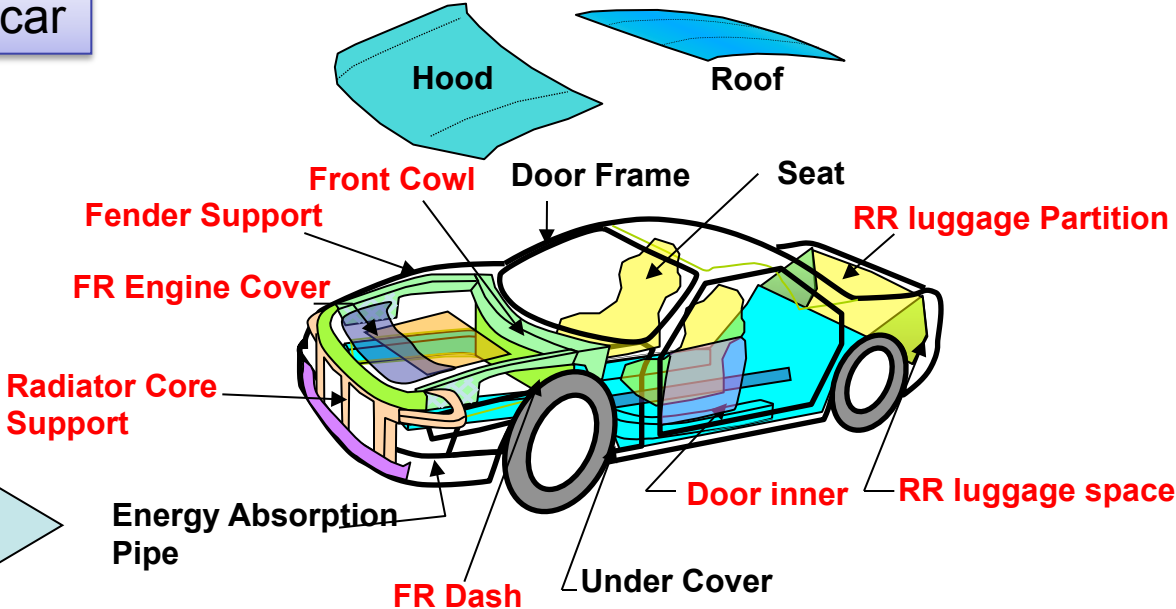
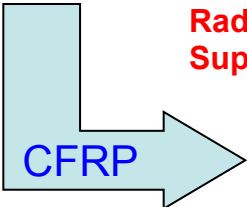
Weight reduction with CFRP application should be effective in CO₂ reduction

Automobile LCA "JCMA Model"

Conventional car and CFRP car



Standard sedan



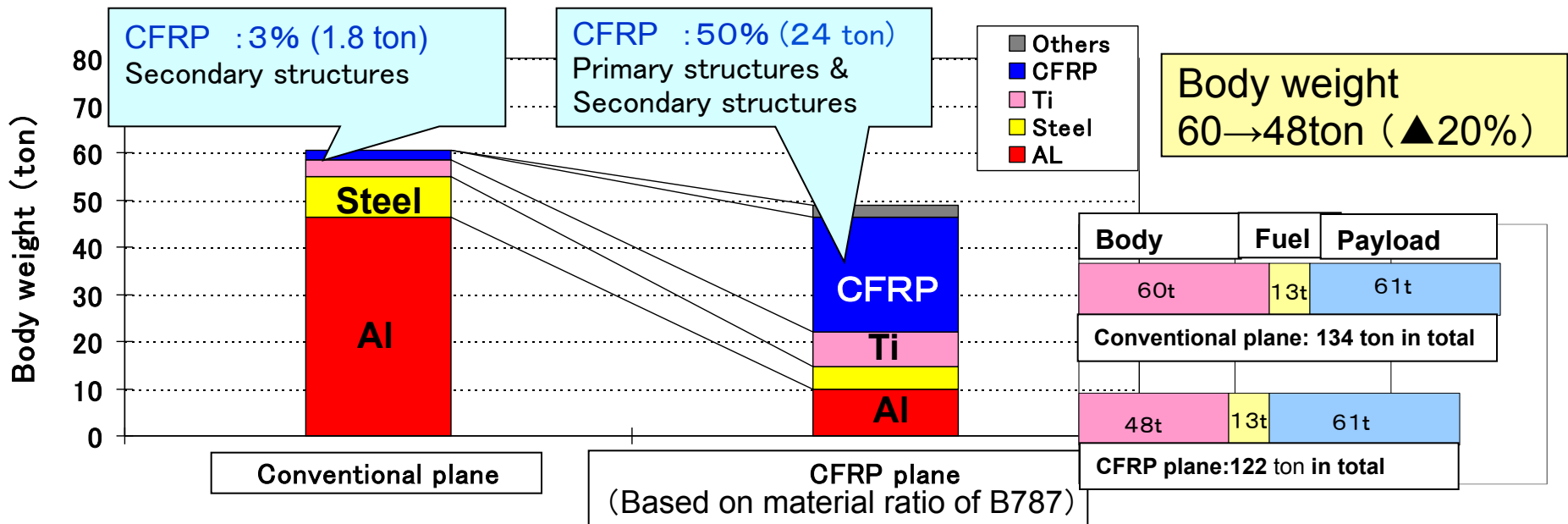
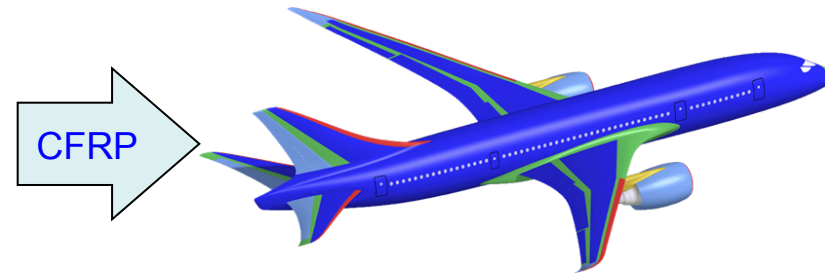
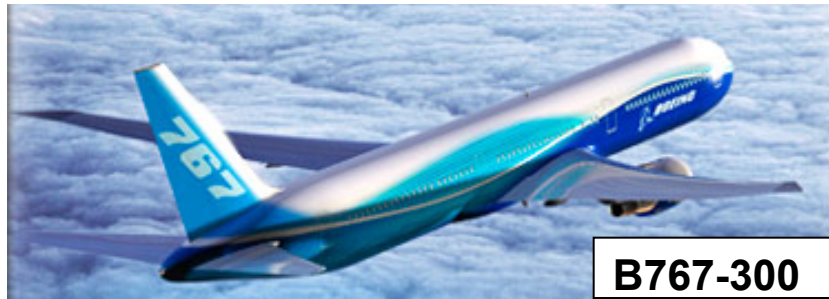
Thermoset CFRP: Panels, Structures (Weight: 30% of steel)
 Thermoplastic CFRP: other parts (Weight: 50% of steel)

Body weight
 1380 → 970kg (▲ 30%)

Body weight can be reduced by 30% with CFRP application

Airplane LCA "JCMA Model"

Conventional plane and CFRP plane



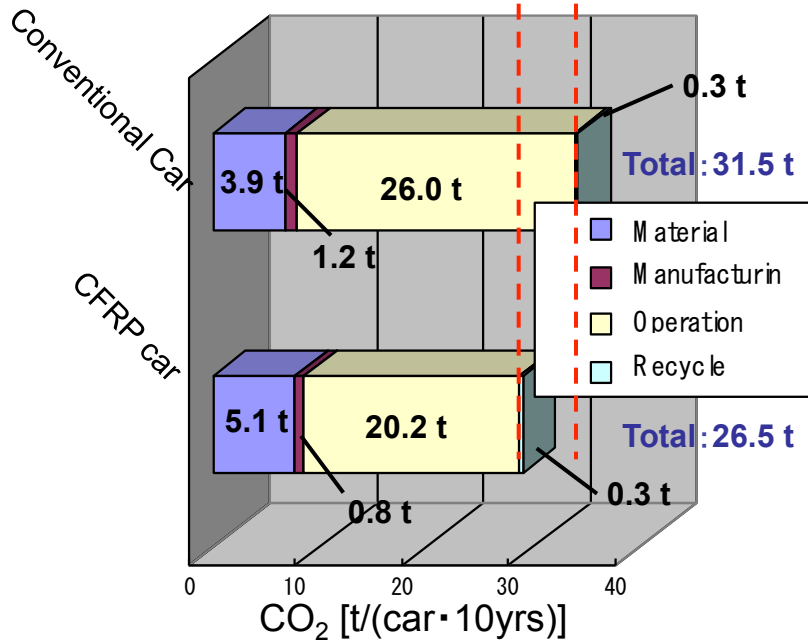
**Body weight can be reduced by 20% with CFRP application
(Equivalent to 9% reduction in total weight)**

“JCMA Model” Summary

CO₂ reduction effects through CFRP application

Automobile

Reduction: 16%



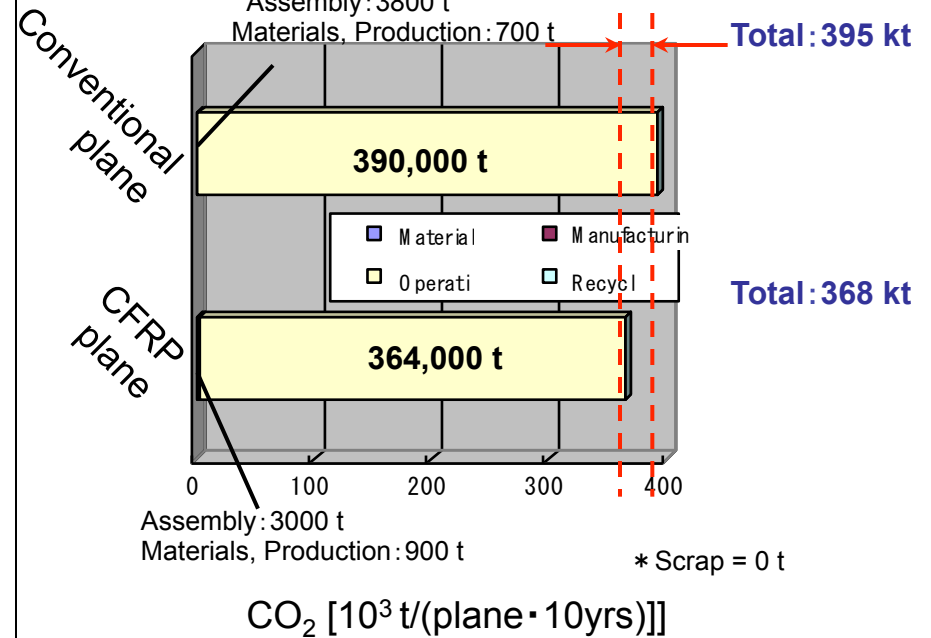
▲ 0.5 t CO₂ Reduction / (car·yr)

Cars possessed in Japan: 42 Million

(Ref. : JAMA)

Airplane

Reduction: 7%



▲ 2,700 t CO₂ Reduction / (plane·yr)

Airplanes possessed in Japan: 430

(100 seats or more)

(Ref. : JAL & ANA)

Equivalent to 1.5% reduction of total CO₂ emission in Japan (1.3 Billion ton/yr)

CO2 Reduction by Using Carbon Fiber

Automobile



Airplane

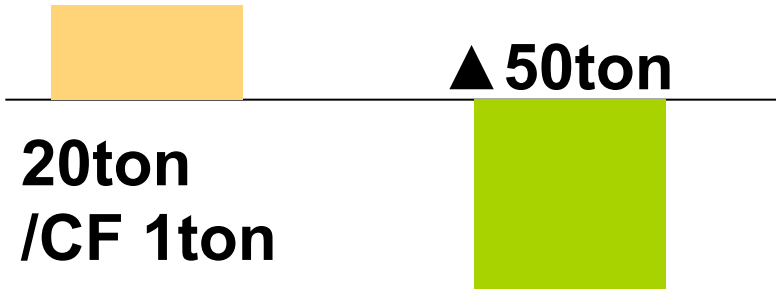


CO₂ Emission in Carbon Fiber Production

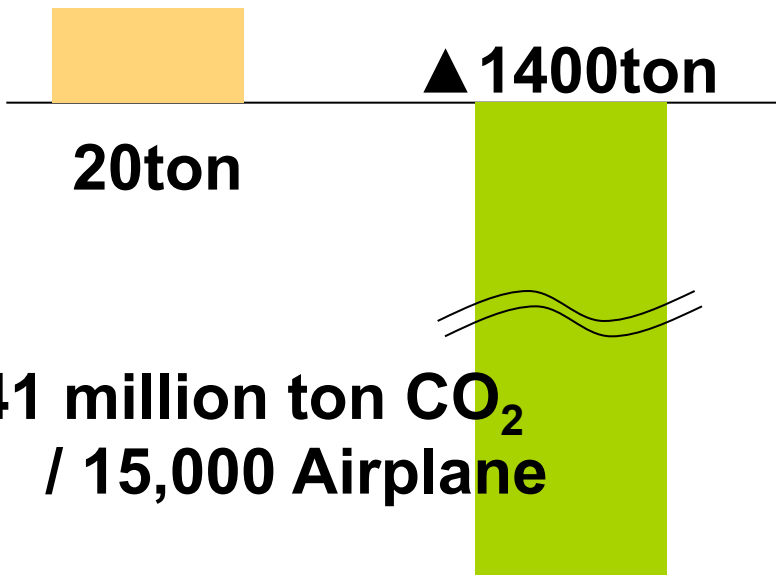
LCA CO₂ Reduction

CO₂ Emission in Carbon Fiber Production

LCA CO₂ Reduction



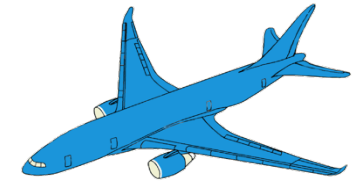
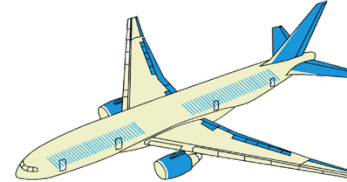
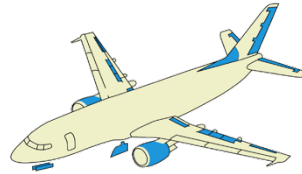
19 million ton CO₂
/ 37 million Auto



41 million ton CO₂
/ 15,000 Airplane

From the view point of LCA, carbon fiber was considered as environmental friendly material.

Boeing-Toray Long Term Partnership



NASA AACE program

Secondary structures for 757/767

Partial primary structures for 777

Full primary structures for 787

1970

1980

1990

2000

2010

Sales & Production

Collaborations

R&D

1970

1980

1990

2000

2010

Start fundamental research

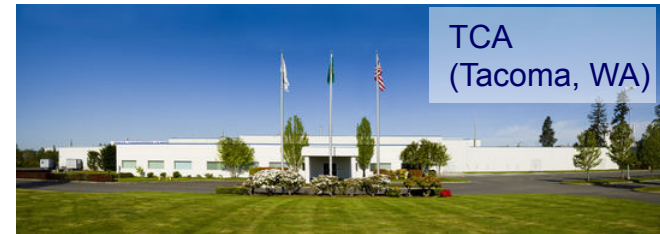
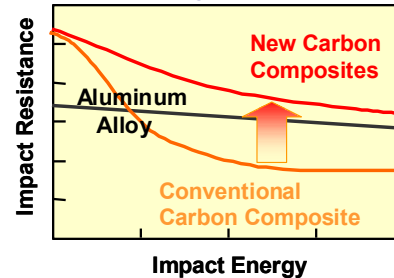
Commercialization (first in the world)



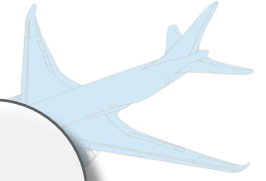
High strength and tough material

Open US plant

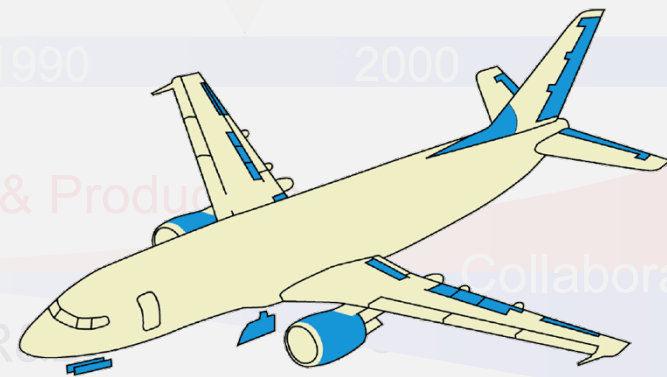
Open US Development Center



Boeing- Toray Long Term Partnership



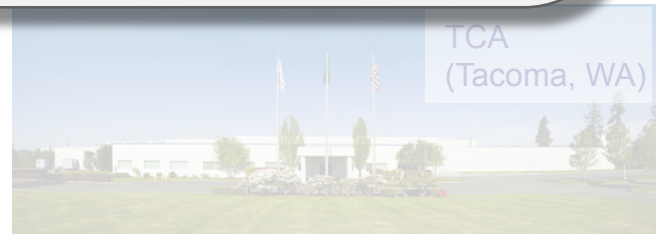
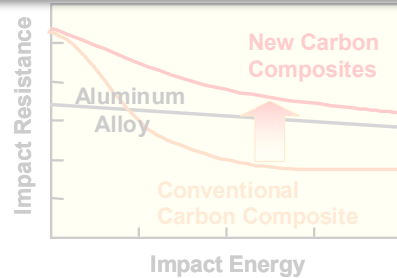
The Beginning: First Application



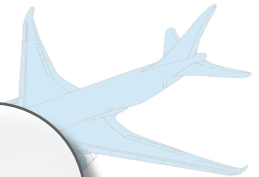
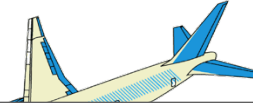
Commercialization

Secondary structures for 757/767

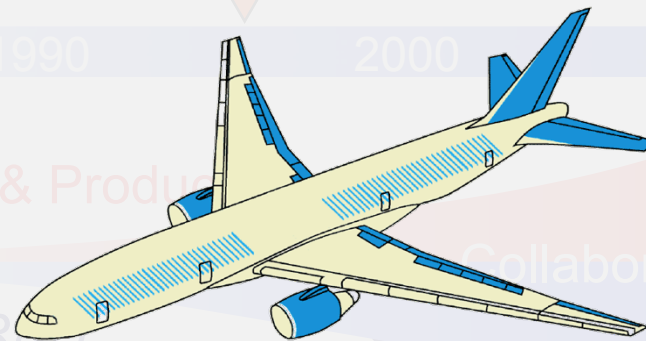
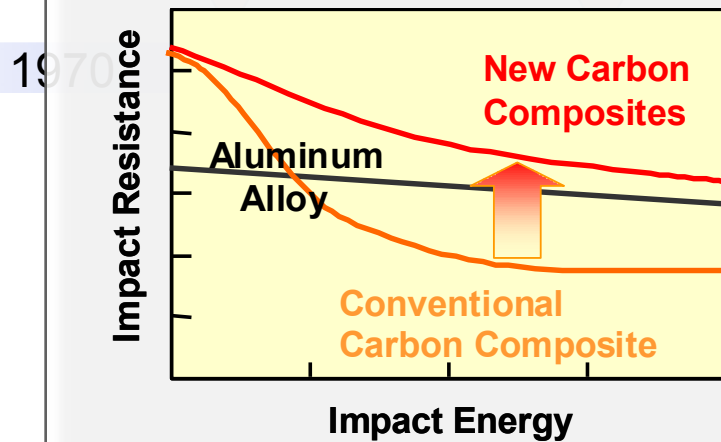
Start fundamental research



Boeing- Toray Long Term Partnership



The Challenge: Primary Structures



2010

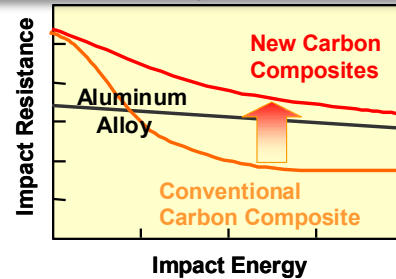


2010

High strength and tough material

Partial primary structures for 777

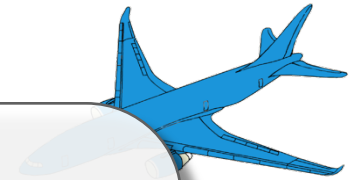
Start fundamental research



TCA (Tacoma, WA)



Boeing- Toray Long Term Partnership



The Collaboration: Expansion of Application

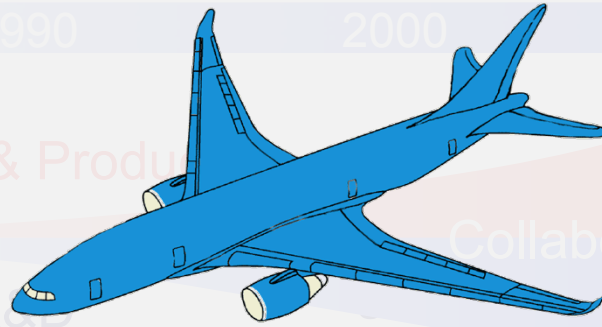
1970



1990

2000

2010



Full primary structures for 787

1970

US plants production & tech support

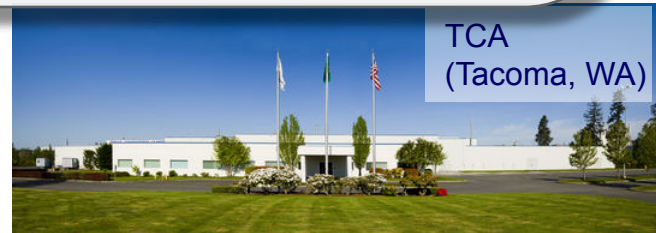
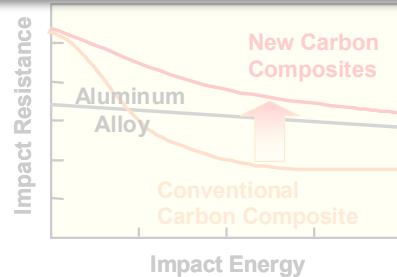
1980

1990

Primary structures for 787

2010

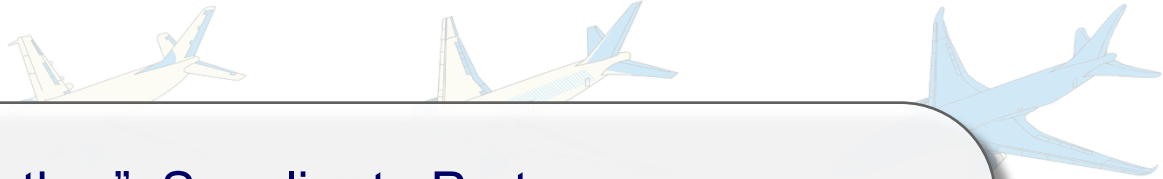
Start fundamental research



TCA (Tacoma, WA)

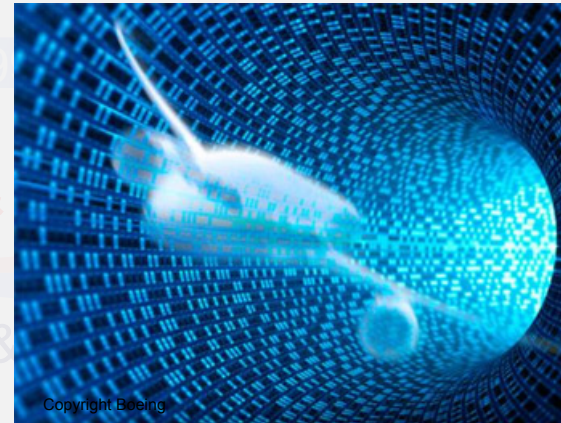
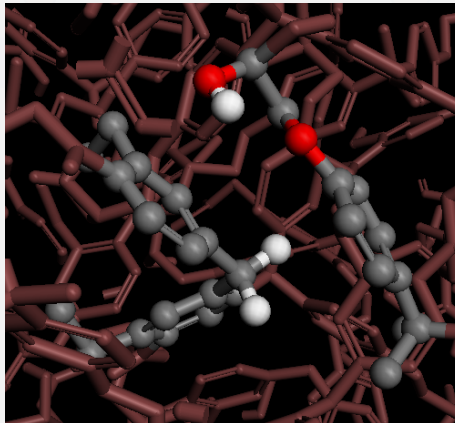


Boeing- Toray Long Term Partnership



“Working Together”: Supplier to Partner

1970



2010

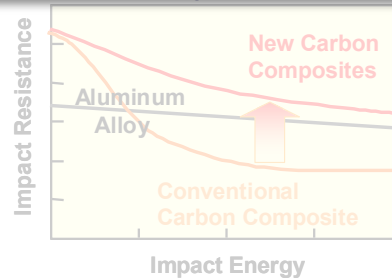
1970

Collaboration from
fundamental research

Next generation
aircraft

2010

▲
Start
fundamental
research



TCA
(Tacoma, WA)

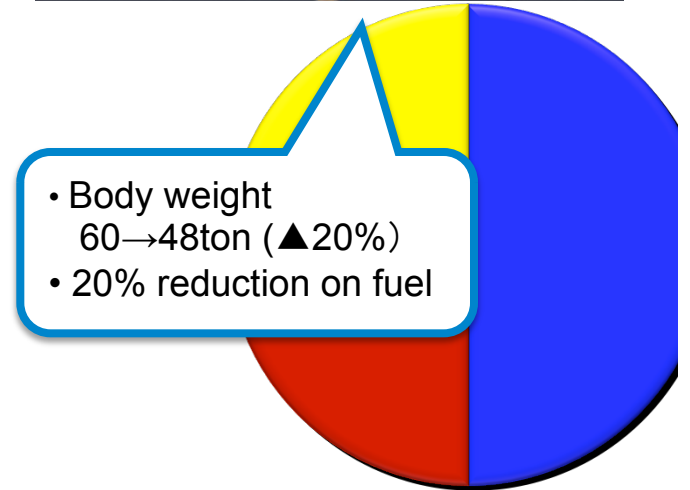
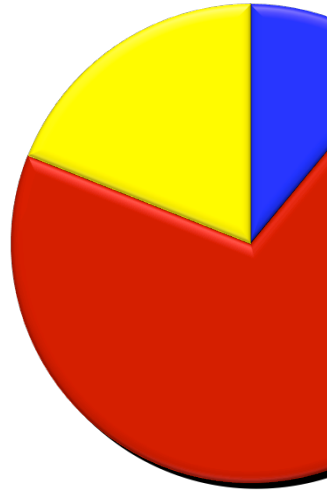
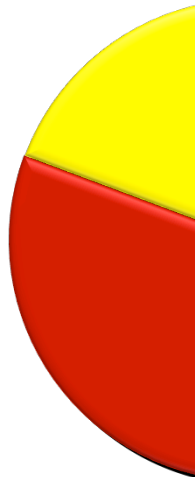
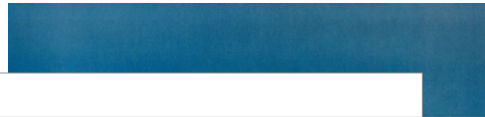


Expansion steps of CFRP application for airplane

B767 (1982)

B777 (1995)

B787 (2011)



- Body weight 60→48ton (▲20%)
- 20% reduction on fuel

		Secondary	Secondary
Amount of CFRP / aircraft	1.5 tons (3%)	Approx. 10 tons (12%)	Approx. 35 tons (50%)

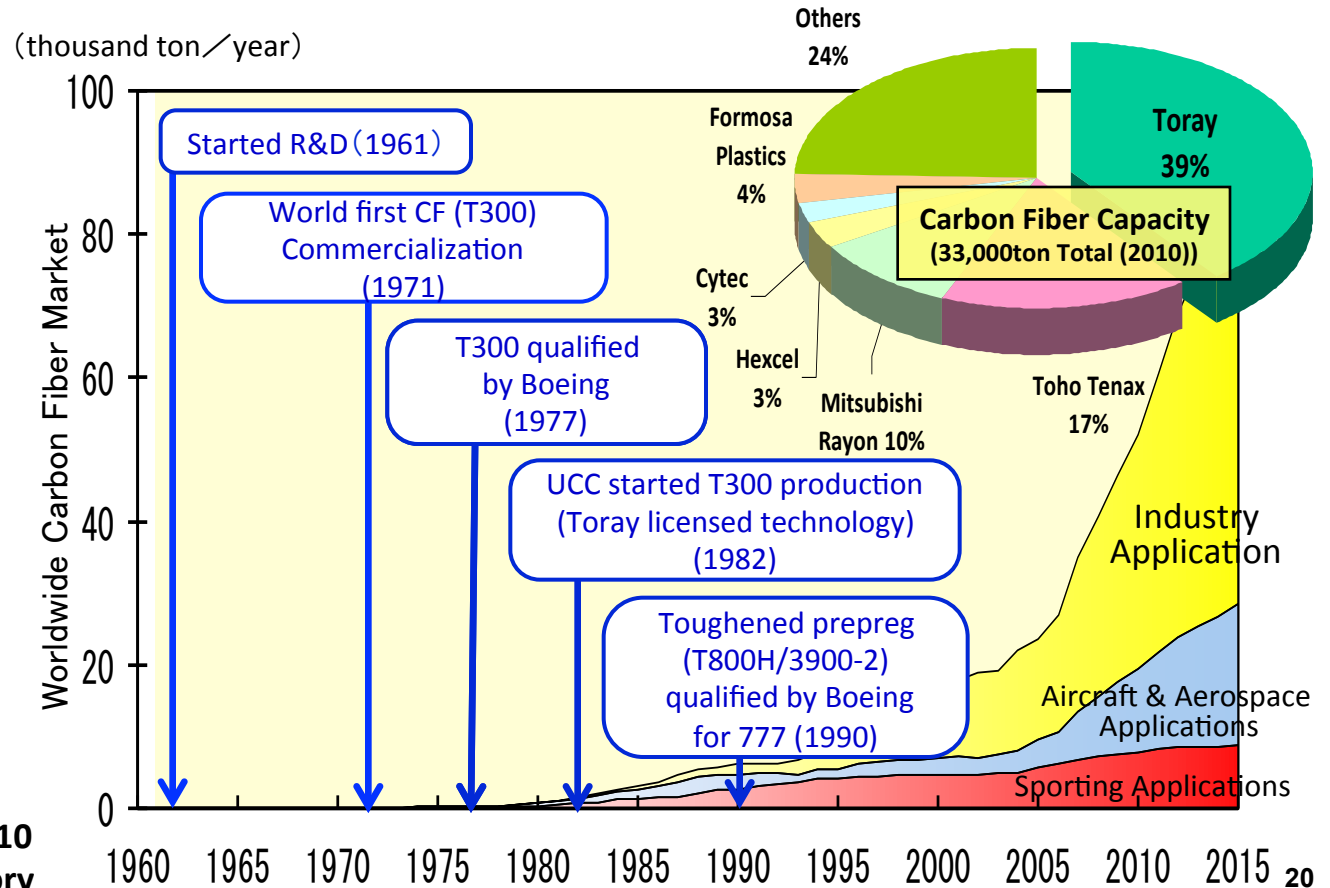
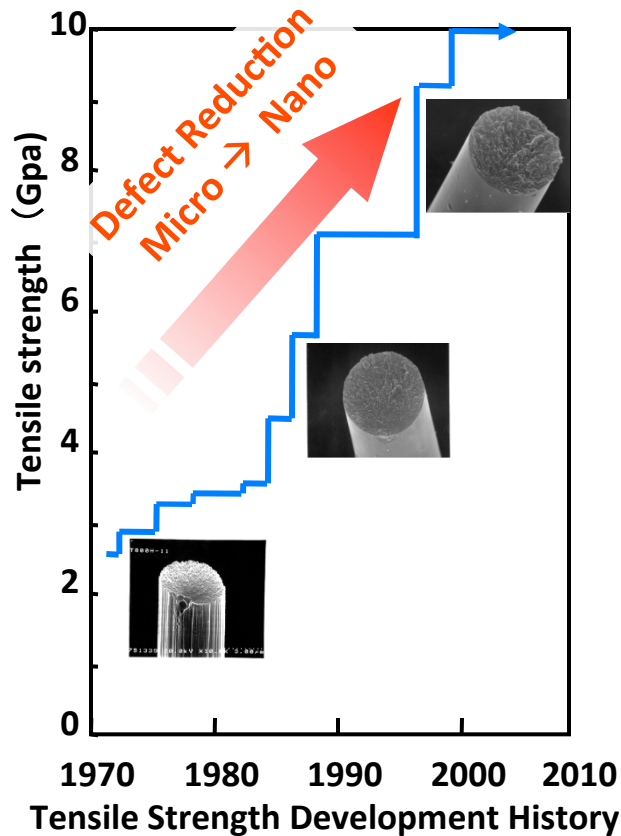
Carbon Fiber Development



Innovation by Chemistry

➤ The Key to Success

- Right decision by top management
 - Toray's platform technology – Polymer chemistry, Fiber, Interfacial control
 - Long term business vision – consistent sustained efforts in R&D investment
- Strong partnership and global alliance with potential users;
 - High-end sport goods manufactures in Japan, Boeing, Airbus, and large auto manufacturers
- Strategic investment

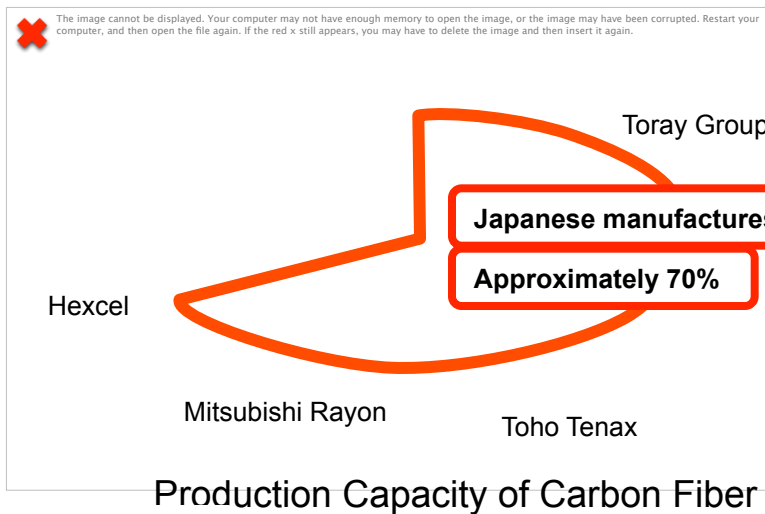


Carbon Fiber Manufacturer

	Company name	1970	1975	1980	1985	1990	1995	2000	Current name
Japan	Toray	[Blue bar from 1970 to 2000]							Toray
	Toho Rayon	[Pink bar from 1975 to 2000]							Toho Tenax
	Mitsubishi Rayon	[Green bar from 1980 to 2000]							Mitsubishi Rayon
	A Company	[Black bar from 1980 to 1995]						X	
USA/USA-Canada	Hercules	[Black bar from 1975 to 1995]						▼	Hexcel
	B Company	[Black bar from 1980 to 2000]						X	
	C Company	[Black bar from 1980 to 1990]					X		
	UOC / BP Amoco	[Black bar from 1980 to 2000]						▼	Cytec
	D Company	[Black bar from 1985 to 1990]					X		
	E Company	[Black bar from 1975 to 1990]					X		
	Sigri / Hoechst	[Black bar from 1975 to 1995]						▼	SGL Carbon
	F Company	[Black bar from 1985 to 1990]					X		

▼ : Reduced scale due to M&A

x: Withdrew or Sold



Japan has the lead in Carbon Fiber business

Key Points for Innovation

INNOVATION

Technology

Management

- Establish world No.1 position in core technology
- Continuous development effort

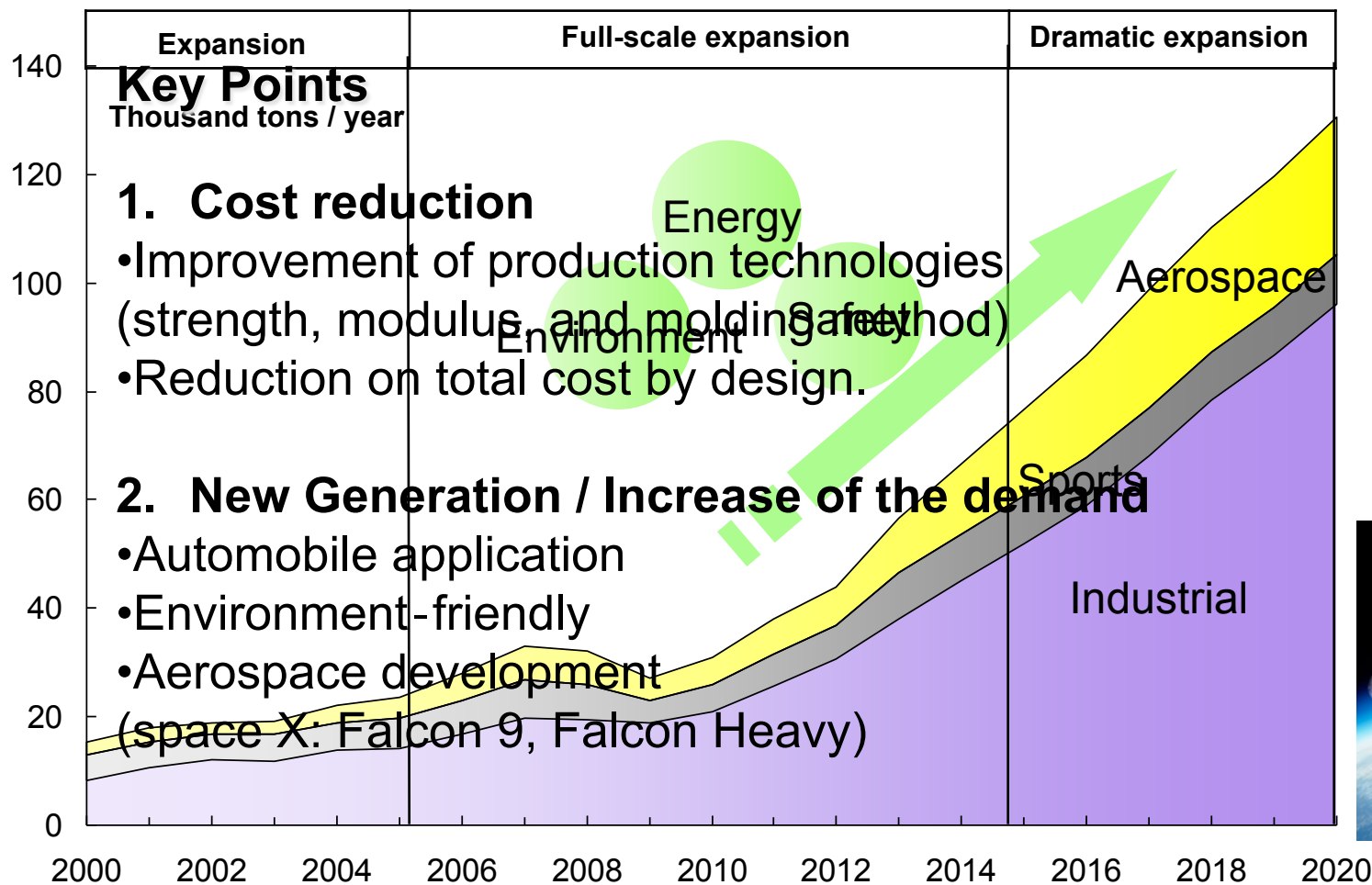
Ex; unable to make revolutionary aircraft "B787" without new materials.

- Management with a long-term vision
- Continuing and diligent Investment for technical development

Ex;
Our carbon fiber business was in the red for 30 years.
New materials takes a long time to get a certification.

Upcoming prospects for CFRP

The demand for CFRP is expected to increase to...



'TORAY'
Innovation by Chemistry

Thank you for your kind attention.