<IT-2010 IR Seminar – No. 4 (Automobiles / Aircraft)>

October 7, 2008

'TORAY'

Innovation by Chemistry

Business Strategies through The Establishment of the A & A Center in Nagoya Plant

Chiaki Tanaka

Executive Vice President and Representative Director

Toray Industries, Inc.

Contents

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- **Midterm Business Strategies "IT-2010" and the Creation of Advanced Materials**
- The Era of Protecting the Global Environment and Toray's EcoChallenge
- The Automobile Industry Entering a Great Revolutionary Era
- Concept for A & A Center and Restructuring of Nagoya Plant
- Expansion Plan for Automotive Business

Midterm Business Strategies, IT-2010

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April 2002 — April 2006

Long-term vision

AP-New TORAY 21 → **AP-Innovation TORAY 21**

Mid-term Business Strategies

NT21

「Corporate Structure Reinforcement・defensive management postures」

-Breakaway from Crisis -

NT- II

「Offensive management postures」

-Establish foundation for further growth -

IT-2010

「Management based on Innovation and Creation」

-Challenges for further growth -

Toward a Global Top Company of Advanced Materials

Goals in and around 2010

- Net sales ¥1,800 billion
- Operating income ¥150 billion
- Operating income to net sales ratio 8.3%
- ROA : 8%
- ROE : 11%

2002 April	2004 April	2006 October	Around 2010

Basic Strategies (Transformation to a highly profitable business group)

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1. Transforming to a highly profitable business group	Transform to a highly profitable business group while continuing business expansion ① 5% annual growth in net sales ② 10% annual growth in operating income → "5-10 Growth Plan" Improving capital efficiency ① ROA : over 8% ROE : over 11% around 2010
2. Expanding Strategically Expanding Businesses (profit growth driver)	Increase profit by expanding Strategically Expanding Businesses (IT-related products and Carbon Fiber Composite Materials) while securing stable profit by Foundation Businesses
3. Expanding Strategically Developing Businesses (next profit growth driver)	Develop strategically next generation profit growth driver businesses after 2010 (Life Science, Water Treatment, Environmental friendly businesses)
4. Advancing business structure reform	Advance business structure reform by expanding Strategically Expanding Businesses and Strategically Developing Businesses ① Double net sales in Strategically Expanding Businesses and Strategically Developing Businesses around 2010 ② Expand their ratio of net sales from the current 25% to 40% around 2010
5. Expanding advanced materials	Expand advanced materials sales in every segment and increase their ratio of net sales ① Double net sales in advanced materials around 2010 ② Expand their ratio of net sales from the current 30% to 50% around 2010

Basic Strategies (Expansion of advanced materials in 4 major growing business fields)

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Aim for business expansion mainly in advanced materials by providing cross-organizational solutions to the 4 major growing business fields.

Information / Telecommunications / Electronics	▪ Business expansion in the growing market of digital network-related products including flat panel display televisions, cellular phones, and personal computers ▪ Development and sales expansion of innovative products through vertical business integration with key customers ▪ Strengthen competitiveness through integrated operations from plastic/films materials to components
Automobiles / Aircraft	▪ Development of products to meet expanding markets in hybrid cars and car electronics ▪ Expansion of application parts by widening advanced functional availability of carbon fiber composite materials and engineering plastics ▪ Aggressive capacity expansion to meet the growing demand for carbon fiber composite materials
Life Science	▪ Conclusive launch of new drugs which is under development and further expansion of new drug pipelines ▪ Development and commercialization of high value-added medical devices ▪ Creation of innovative bio-tools through bio/nano-technological integration
Environment / Water-related / Energy	▪ Development of new applications for fibers & textiles, plastics and films using such non-petrochemical raw materials as polylactic acids ▪ Global expansion of water treatment businesses with a core of high-performance separation membranes ▪ Development of new materials for next generation energy systems including solar cells, fuel cells, and wind power generation

Toward a Global Top Company of Advanced Materials

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*products in blue :examples of nano-tech products

"Create advanced materials that change the future"
That is Toray's Nano-technology

Toray Core Technologies

Organic synthetic chemistry
Polymer chemistry
Biotechnology

Nano-technology

New Properties Emerge
New Value
"Nano-effect"
Dramatic improvement in properties

- Nano-material
  - CNT
  - Nano-particles (nano-dispersion)
- Nano-structure design control
  - Nano-alloy*
  - Nano-composite
- Nano-surface-treatment
  - Chemical modification
  - Nano-coating
- Nano-process (nano-processing)
  - Nano-imprint
  - Nano-laminates
- Nano-analysis
  - Nano-shape observation
  - Nano-structure analysis/ composition analysis

Innovation of key materials

- Fibers & Textiles — Nano-fiber
- Films — Nano-laminated film
- Resins — High-toughness nano-alloy*
- Chemicals — (Zeolite)

Expansion of four growing business fields

- Information / Telecommunications / Electrics — Film for data storage, LCF, PDP
- Automobiles / Aircraft — Carbon fiber, impact-absorbing nano-alloy*
- Life Science — Artificial kidney, DNA chip
- Environment / Water-related / Energy — PLA products, water-treatment membrane, fuel cell

* nano-alloy* is one of Toray's trademark

Business Culture of Toray Technology Development

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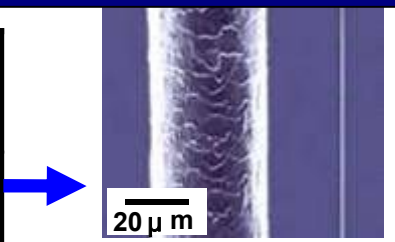
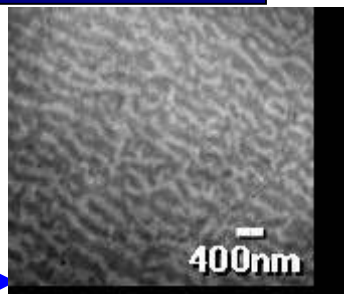
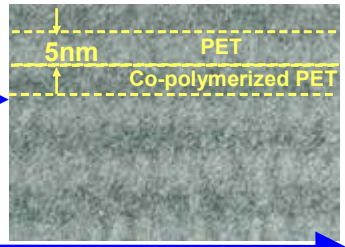
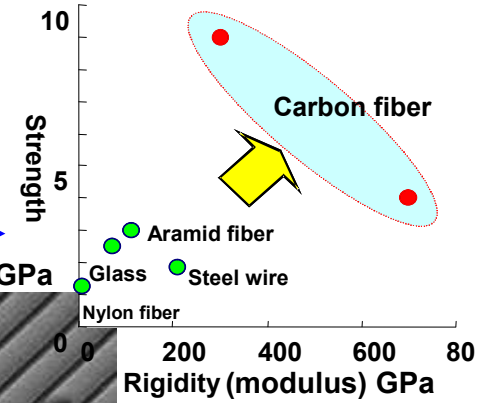
A business culture that pursues the ultimate, challenge in "Innovation of technologies," and create innovative technologies

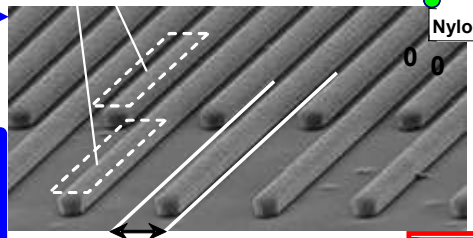
Area	Ultimate Themes	
	Objectives	Contents
Fibers & Textiles	Nano-fiber	Fineness of fiber diameter
Resins	Polymer-alloy	Polymer dispersion size
Films	Multi-layer film	Thinness of film layers
Carbon Fiber Composite Materials	Carbon fiber	Strength and rigidity
Electronic & Information Materials	High-density mounting board	Processing accuracy of wiring pitch
Health care	DNA chip	Structure design control of nano-columnar
Water Treatment	High boron-rejection membrane	Pore size control of RO membranes
Engineering Development Center	Realization of innovative technologies through creation of new processing and establishment of process for mass-production	

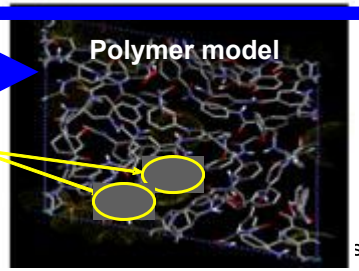


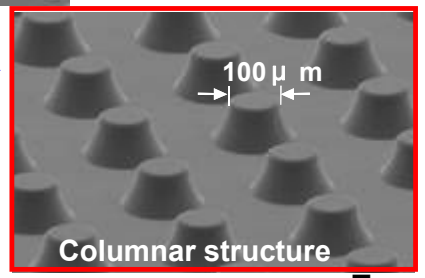












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Various Global Environmental Issues

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Urgent response to various global environment issues is required

Global warming / Extreme weather

Acid rain

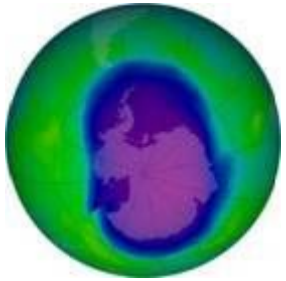
Air pollution

Desertification

Sea pollution

Oil exhaustion

Ozone layer depletion



Biodiversity loss

Forest loss

Global Environmental Issue Initiatives by the Industrial World

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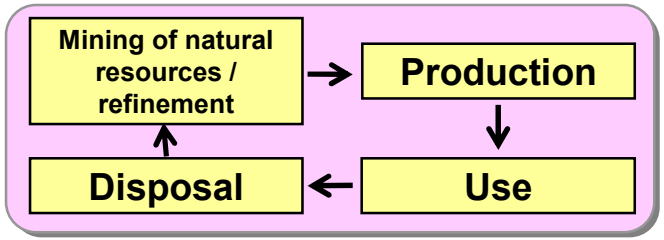
Responses to GHG reduction….
(GHG: Green House Gas)

Global warming
Extreme weather
↔
GHG increase
・use of fossil fuels
・deforestation, etc.

Ensuring food, water, energy
Protection from natural disasters / reconstruction plans

CO_2 reduction from a Carbon-Balance* perspective

* quantification value of CO_2 balance over total product-life cycle



Contribute to GHG reduction during mining / refinement / production / use/ disposal

Globally sustainable recycle-oriented society (combine "environment" and "economy")

★ Environment-responsive R&D is substantial
★ Accelerate innovation based on multifaceted integration

→ **Chemistry will save the earth**

Key points

- Energy conservation / New energy resources
- Non-petrochemical raw materials
- Water-treatment / Air-purification / Environmentally friendly
- Recycle

Toray Project EcoChallenge

Dow Jones Sustainability Indexes Member 2008/09 | KLD Global Climate 100 INDEX | MS-SRI モーニングスター社会的責任投資株価指数 Morningstar Socially Responsible Investment Index

TORAY Innovation by Chemistry

Generic name of Toray Group activities (projects) for the initiatives to progressively save resources and protect the global environment, with comprehensive perspectives concerning ecology, toward the development of a sustainable recycle-oriented society.

	Fibers & Textiles	Films	Resins Chemicals	Carbon Fiber Composite Materials	IT-related Products	Water Treatment / Environment
Energy conservation	Highly-efficient manufacturing process, energy-saving forming technology/energy-saving process of membranes, modernizing of in-house power generation					
	Energy-saving building materials (insulation/heat shield/ heat exchange material		Weight-saving of automobiles/aircraft: Resins for automobiles; Advanced composite materials for automobiles/aircraft		Advanced EL materials	Membrane treatment method Water treatment
New energy resources	Battery materials		Wind-power generation			
	Materials for lithium-ion battery / fuel cell					
	Materials for solar cell					
Non-petrochemical raw materials (bio-chemicals)	Nonfood biomass-origin polymer products					Membrane Bioreactor
	Cellulose fiber (solvent-free)		Chemical process with membranes			
Water treatment/ Air-purification/ Environmentally friendly	Heat resistant bag filter			CNG/H_2 tank	Waterless printing plate	Water treatment/ Modules/ Systems
	Eco-process of man-made suede	Film for coating alternatives			BM resin	
Recycle	Halogen-free flame retardant materials					Air filter
	PET, N6, PBT, ABS, PPS		DMSO	CFRP		

Three-Year Environmental Plan

EcoChallenge

[Energy conservation] CO_2 Reduction with Carbon Fibers : Aircraft

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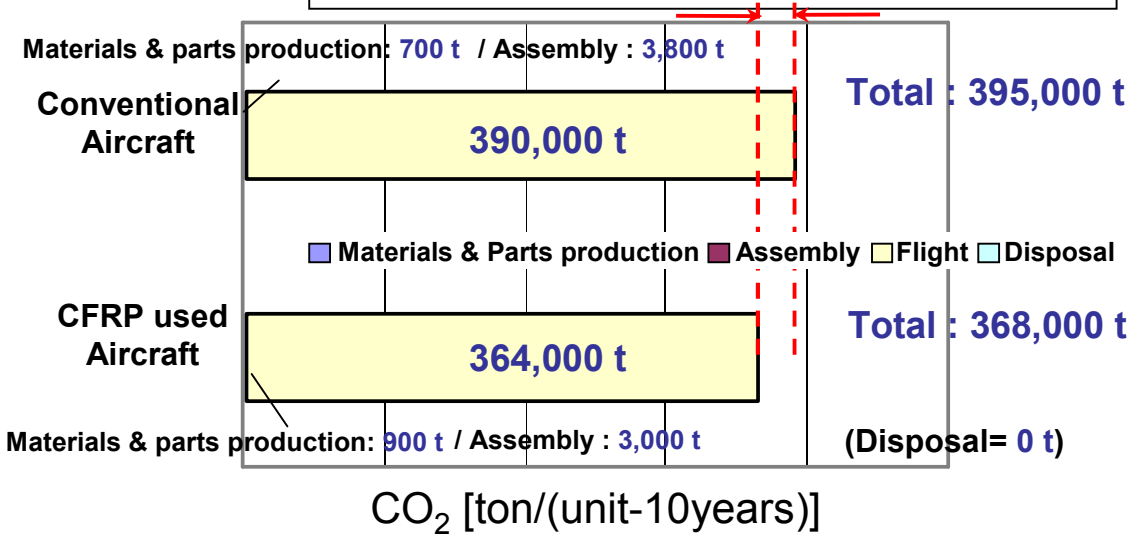
<Cooperation> Tokyo University, Pro. Takahashi / Rinoie
Kobe Yamate University, Pro. Feuerherd
ANA, Boeing

<Precondition>
Aircraft : Midsize passenger aircraft (Boeing 767)
Domestic line specification
Flight : Domestic line (Haneda ⇔ Chitose ; 500 miles)
Lifetime operational track : 2,000 flights/yr, 10years
(Source : ANA)

CFRP in use : CFRP50% applied (composition of Boeing 787)
20% lighter in weight (over conventional aircraft)

Per one aircraft

Reduction effect : ▲27,000 tons (7%)

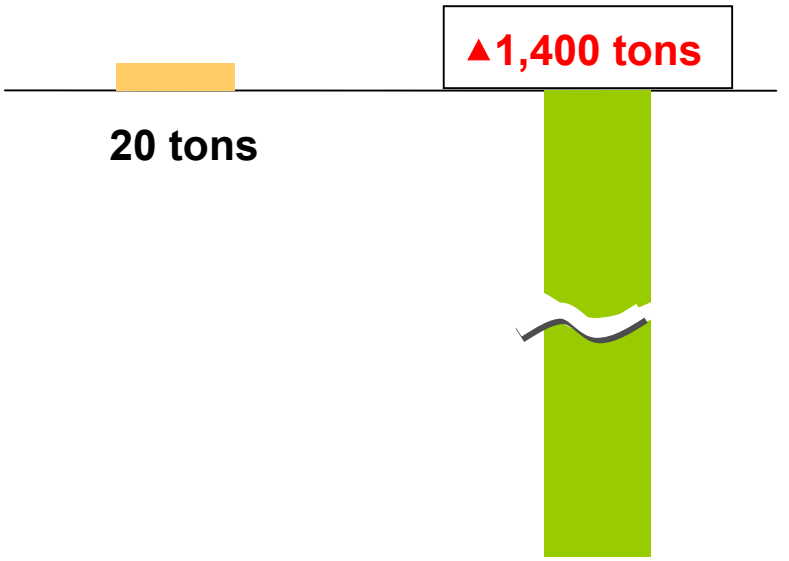


CO_2 [ton/(unit-10years)]

▲2,700 tons CO_2 reduction (unit-year)

Per ton of carbon fiber

(including during manufacture)



▲140 tons CO_2 reduction/(CF1ton-year)

EcoChallenge

[Energy conservation] CO_2 Reduction with Carbon Fibers : Automobiles

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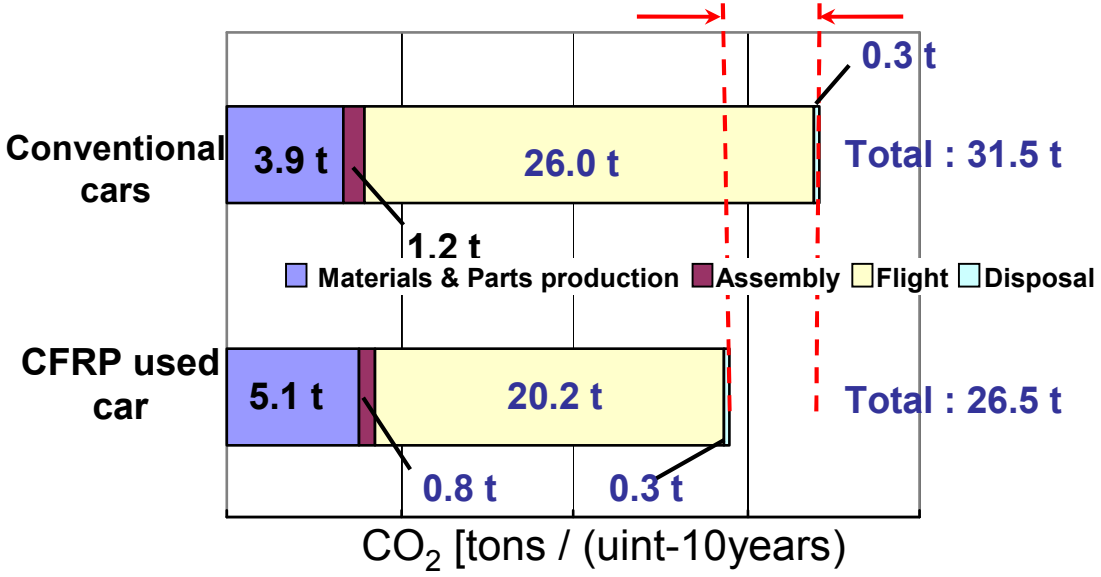
<Cooperation> Tokyo University, Pro. Takahashi
Kobe Yamate University, Pro. Feuerherd
Toyota Motor Corp.

<Precondition>
Vehicle weight : 1,380kg*1 (gasoline-car, 4 doors, FF)
Actual mileage : 9.8km/l *1
Lifetime mileage : 94,000km*2 (average age 10 years)
(Source : *1 JAMA, *2 MLIT)

CFRP in use : CFRP17% applied, 30% light in weight
(over conventional automobile)

Per one vehicle

Reduction effect : 5 tons (16%)

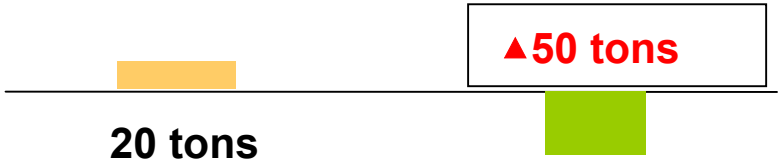


▲0.5 tons CO_2 reduction /(unit-year)

Per ton of carbon fiber

Volume of CO_2 emitted during carbon fiber manufacture

Total CO_2 emission reduction over life of vehicle
(including during manufacture)



▲ 5 tons CO_2 reduction/(CF 1 ton-year)

[Energy conservation] Effects in the Automotive Field with the Increase of Carbon Fibers

CO_2 reduction by vehicle weight

Weight (Kg)	Automobile Rank	Number of Cars (Japan)	CO_2 reduction volume (ton/(unit-yr))
1750~	Luxury sedan, Minivan	approx. 4 million units	0.86
1500~1750	Middle class sedan	approx. 8 million units	0.69
1000~1500	Popular car	approx. 24 million units	0.42
~1000	Compact car	approx. 6 million units	0.35

CFRP in use by 17% to cars weighing over 1,500 kg with large CO_2 reduction effect (30% light in weight)

9 million tons of CO_2 per year can be reduced (equivalent to about 3.5% of total CO_2 emissions derived from Japanese transportation sector)

[New Energy] Initiatives to Develop Technologies Related to New Energy

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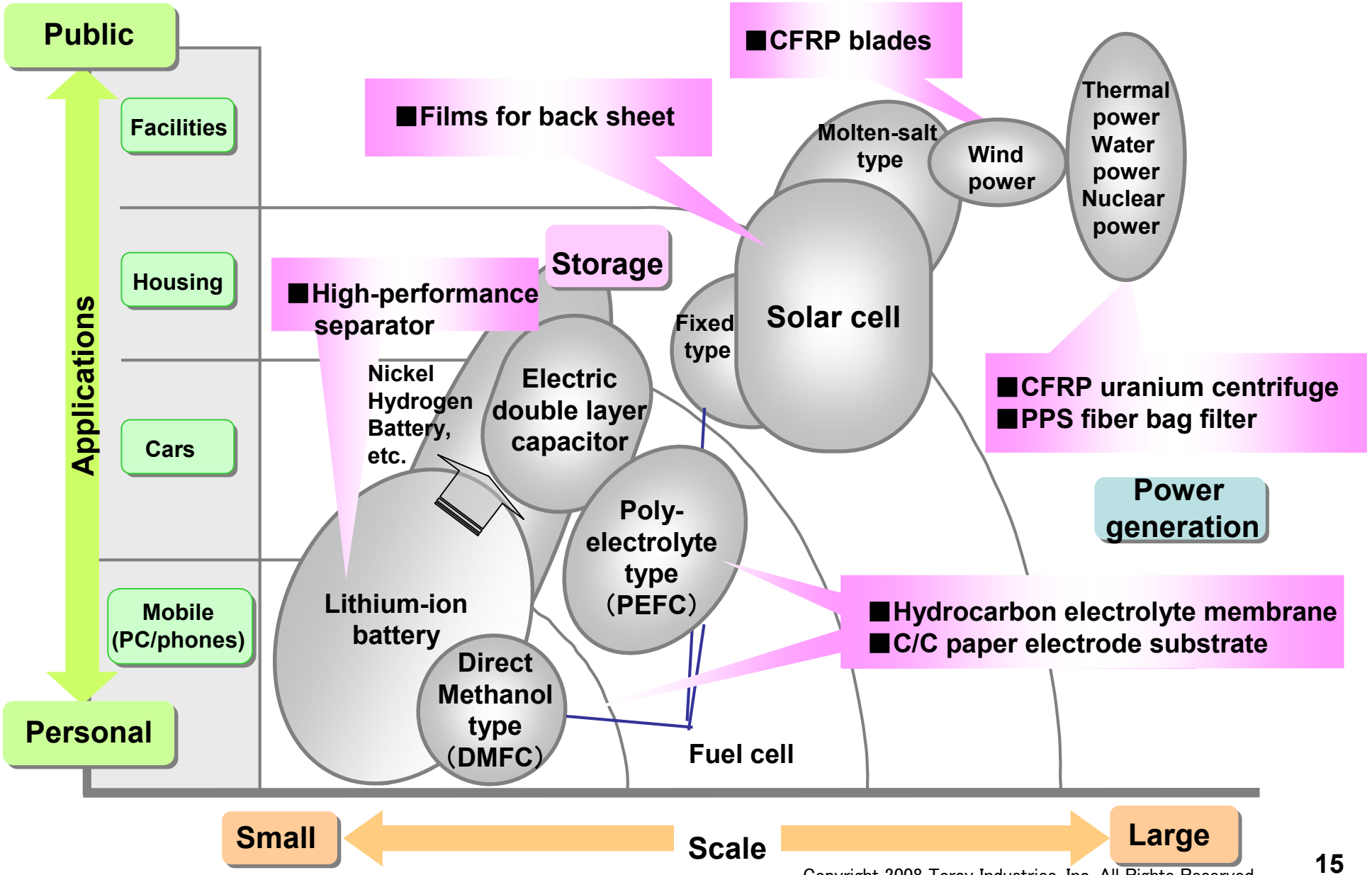

EcoChallenge

[Non-petrochemical Raw Materials] Development of Nonfood Biomass-origin Materials

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Fossil material

Refining / Synthesis → Raw materials → Polymerization → Nylon, Polyester, Acrylic, Polyurethane, etc. → Fibers, Resins, Films, etc.

Biotechnology + **Nano-technology**

Plant-based raw materials
Nonfood

- lactic acid —polymerization→ Polylactic acid (PLA)
- 1,3-propanediol (+TPA) —polymerization→ 3GT*
- cellulose —melt spinning→ Cellulose fiber
- plant oil —nano-alloy→ Flexible heat-resistant films

Polylactic acid products

Toray's Business Domain

Photosynthesis water, carbon dioxide

*3GT : polytrimethylenetelephthalate

Toray promotes developments and commercialization of nonfood biomass-origin materials through the integration of biotechnology and nano-technology.

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The Automobile Industry in a Great Revolutionary Era

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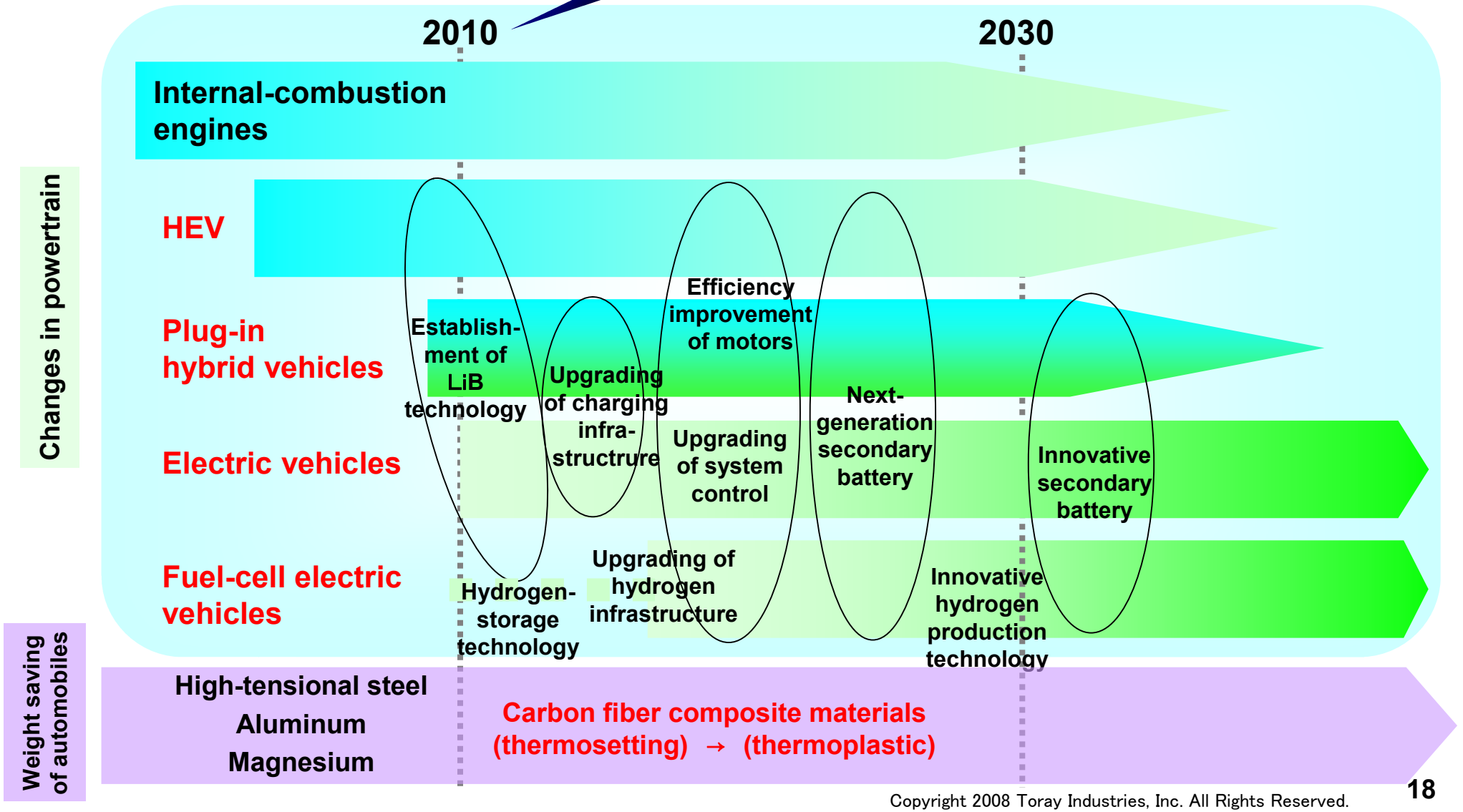
2010 and onward : gasoline internal-combustion engines will shift to electrical systems which will urge "weight-saving" issues



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Geographical Advantage of Nagoya Plant

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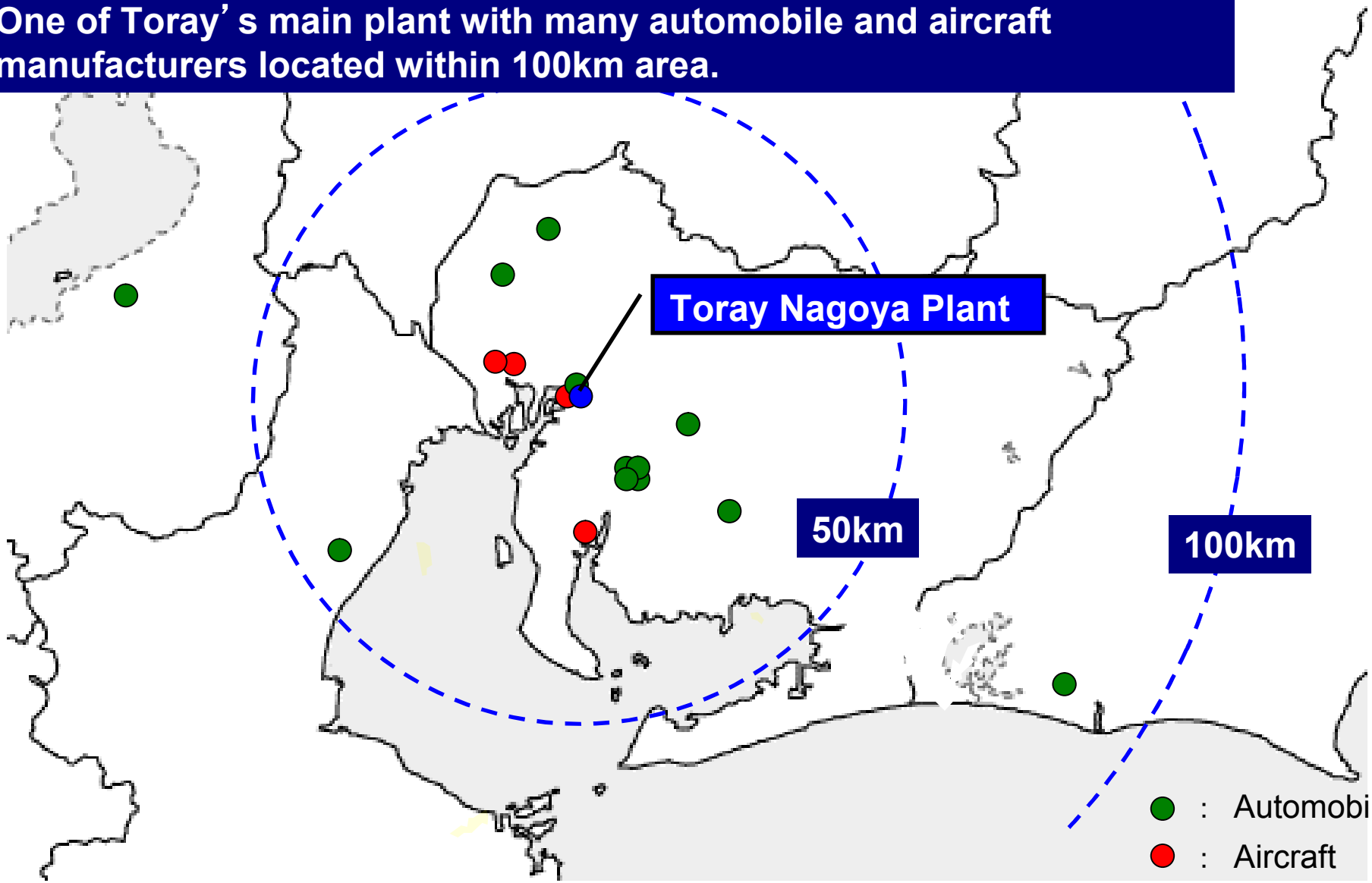
One of Toray's main plant with many automobile and aircraft manufacturers located within 100km area.



Concept for Nagoya Plant A&A Center

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Concentrate Toray's comprehensive ability in the Nagoya area and establish a new development base for technological development through close ties with the automobile and aircraft industries.

A&A Center (Development center for Automobiles & Aircraft)

Plastics Application Technology Development Center [Opened in 1989]

[Automobile and E&E Application]
- Development of engineering plastics
- Development of molding technologies for engineering plastics

Automotive Center [Opened in 2008]

[Automobile Application]
- Offering solutions, project management (collaboration with outside companies and inside department, integration of advanced materials technologies of Toray Group)
- Development of automobile-related elemental technologies (evaluation and analysis)

Advanced Composite Center [Scheduled to open in 2009]

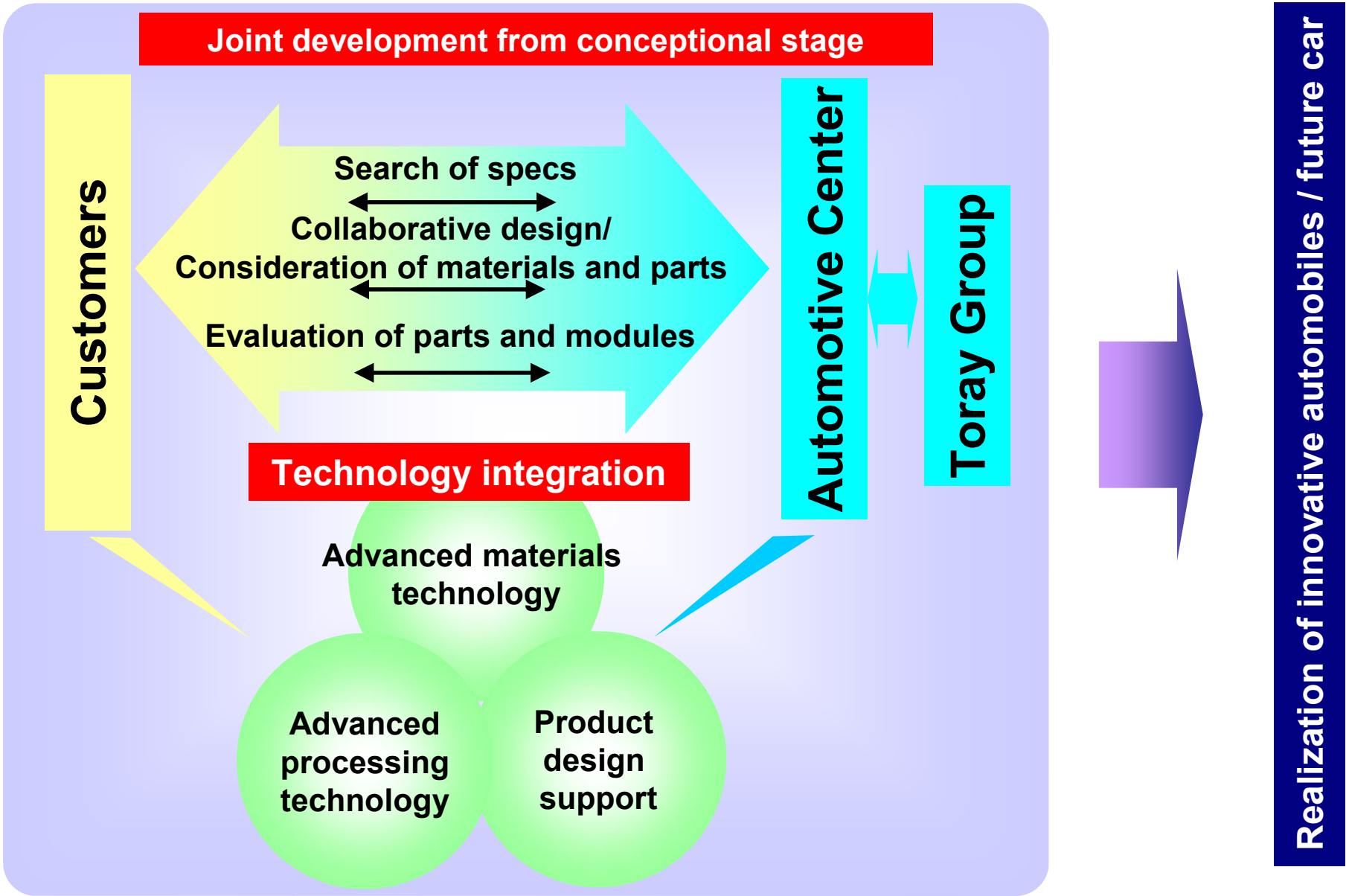
[Automobile and Aircraft Application]
- Development of composite materials
- Development of composite molding technology

The 3 Centers cooperate and supplement each other to conduct technology development

Collaboration

Research laboratory, Development center, each technical department (resins, chemicals, films, electronic & information materials, affiliated companies, etc.)

Targets for the Establishment of Automotive Center



Outline of Transfer of Composite Development Functions

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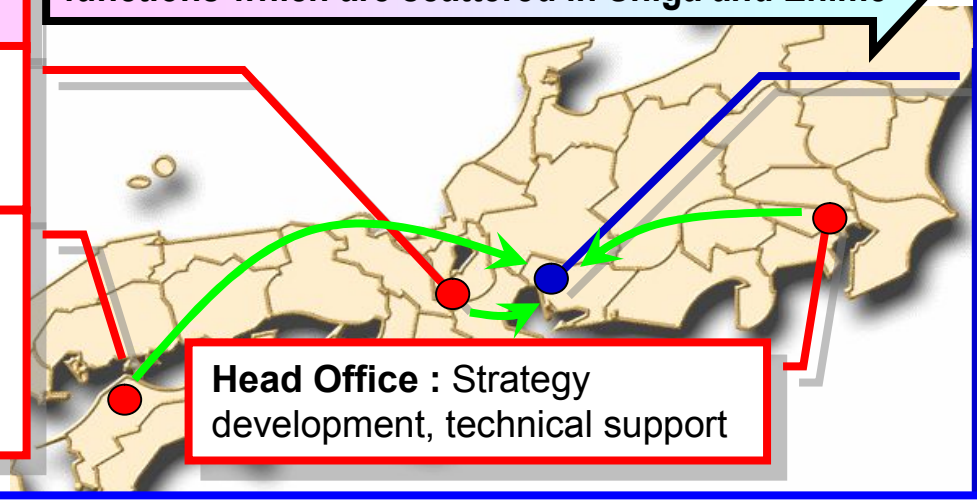
Synergy effect and speed-up of development attributable to the consolidation/reinforcement of composite development functions.

Existing composites development bases

Shiga Plant
Composites Technical Department

Ehime Plant
Composites Technical Department
Composites Development Center

Consolidate/reinforce composite development functions which are scattered in Shiga and Ehime



Head Office : Strategy development, technical support

Future composites development base

Nagoya Plant
Advanced Composite Center (ACC)

(1) Automobiles
①Thermal cure high-speed RTM technology
②Filament-winding molding technology
(2) Aircraft
①Prepreg molding technology
②A-VaRTM technology

[Image of ACC]

- Concentrate comprehensive capability of development
- Strengthen development functions through the improvement of experimental/evaluation facilities
- Integration of Toray Group resins and chemicals technologies
- Strengthen collaboration with vital customers in the Chukyo district

Outline of Transfer of Composite Development Functions

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In the automobiles and aircraft area, Toray will add advanced design/process technologies of the Advanced Composite Center to the innovative technologies created through co-development with customers or national projects, and apply them to production.

Automobiles

Aircraft

Technology establishment / Production application

Advanced technologies of Advanced Composite Center			
Materials/Evaluation technology	Design/Analysis technology	Molding technology	Process technology

Co-development / National project
(High-speed RTM, A-VaRTM materials, etc.)

Structural Reform of Nagoya Plant

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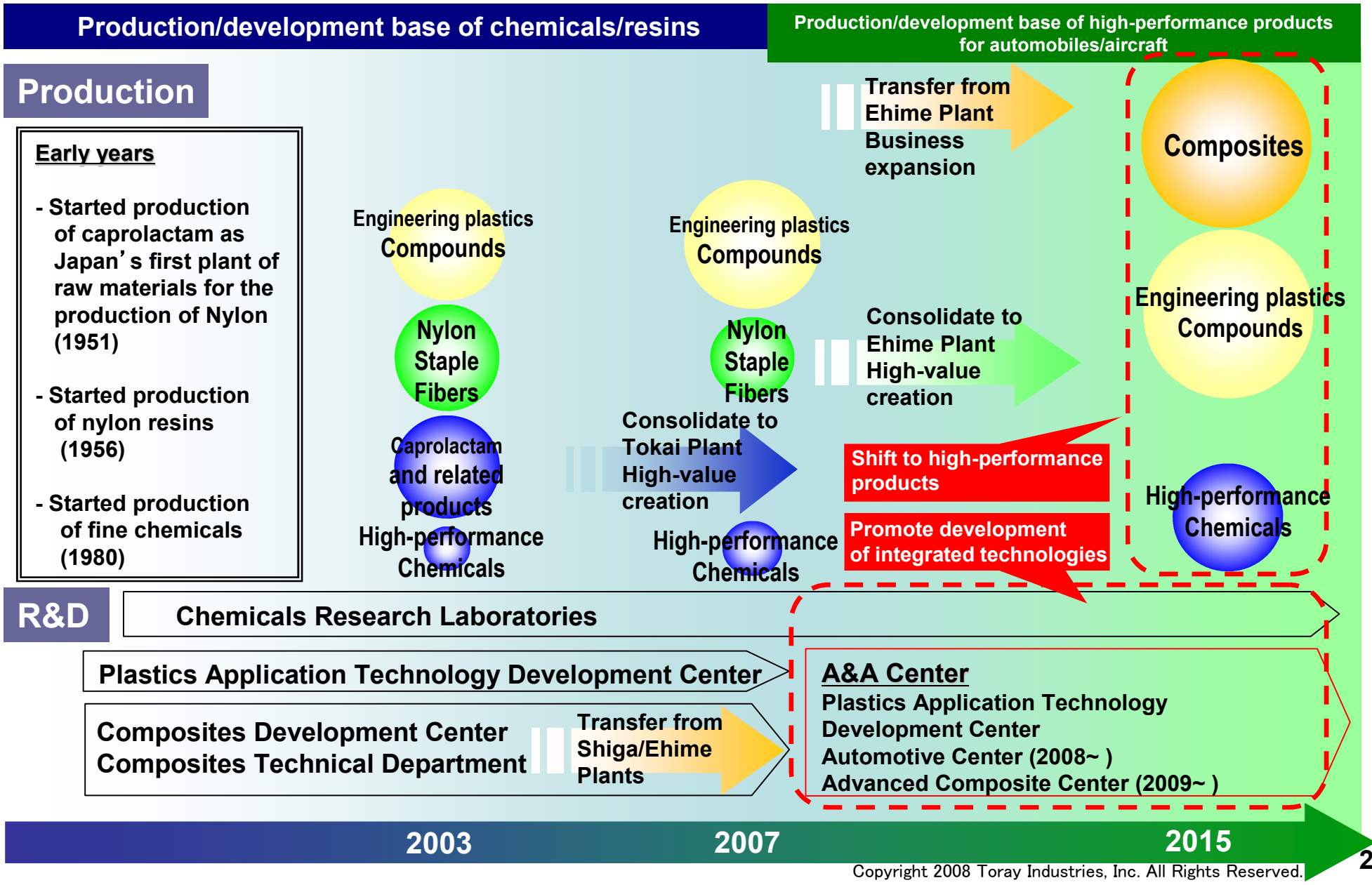

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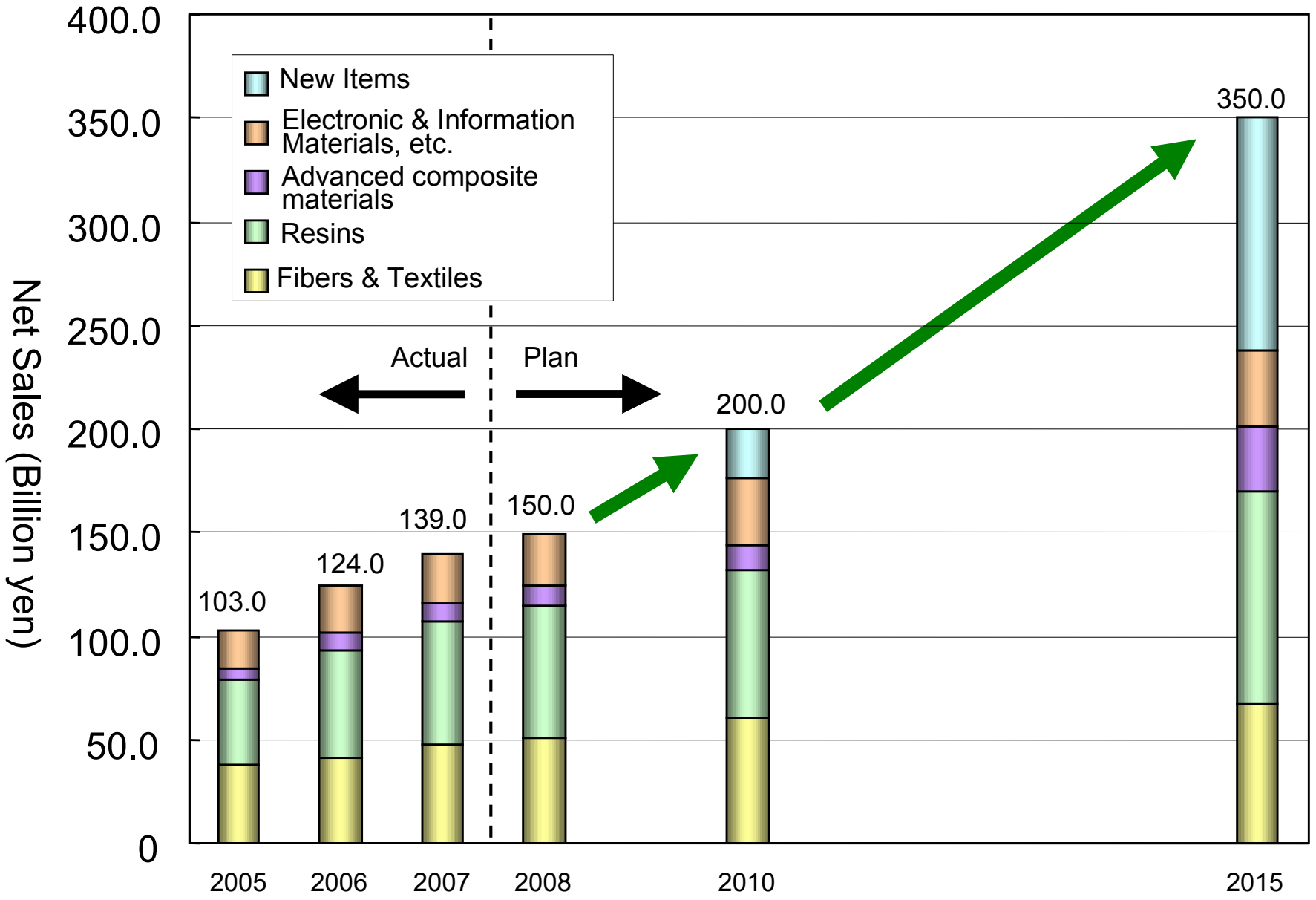
Expansion Plan for Toray Automotive Business



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The Automotive Center

Toray Industries, Inc.
General Manager
Automotive Center
Yasuo Suga

Function of Each Organization of A&A Center

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A&A Center — Development site for automobile and aircraft application — Nagoya Plant

Plastics Application Technology Development Center
(Automobile and E&E application)
Development of engineering plastics
Development of molding technologies for engineering plastics

Automotive Center
(Automobile Application)
・Offering solutions
・Project management
(collaboration with outside companies and inside departments, integration of advanced materials technologies of Toray Group)
・Elemental technologies
(evaluation and analysis)

Advanced Composite Center
(Automobile and Aircraft application)
・Development of composite materials and composite products
・Development of composite processing technologies

Name	Plastics Application Technology Development Center	Automotive Center	Advanced Composite Center
Main equipments and facilities	(Materials) Molding equipments Material evaluation facilities	(Parts ~ Modules) Large molding/processing equipments Facilities for dynamic evaluation of parts	(Materials ~ Parts) CF base materials processing equipments Large press/ RTM molding equipments
Open	October, 1989	October, 2008	April, 2009 (scheduled)

The 3 Centers cooperate and supplement each other to conduct technology development
(Numbers of staff (plan): Total 250 members at 3 centers)

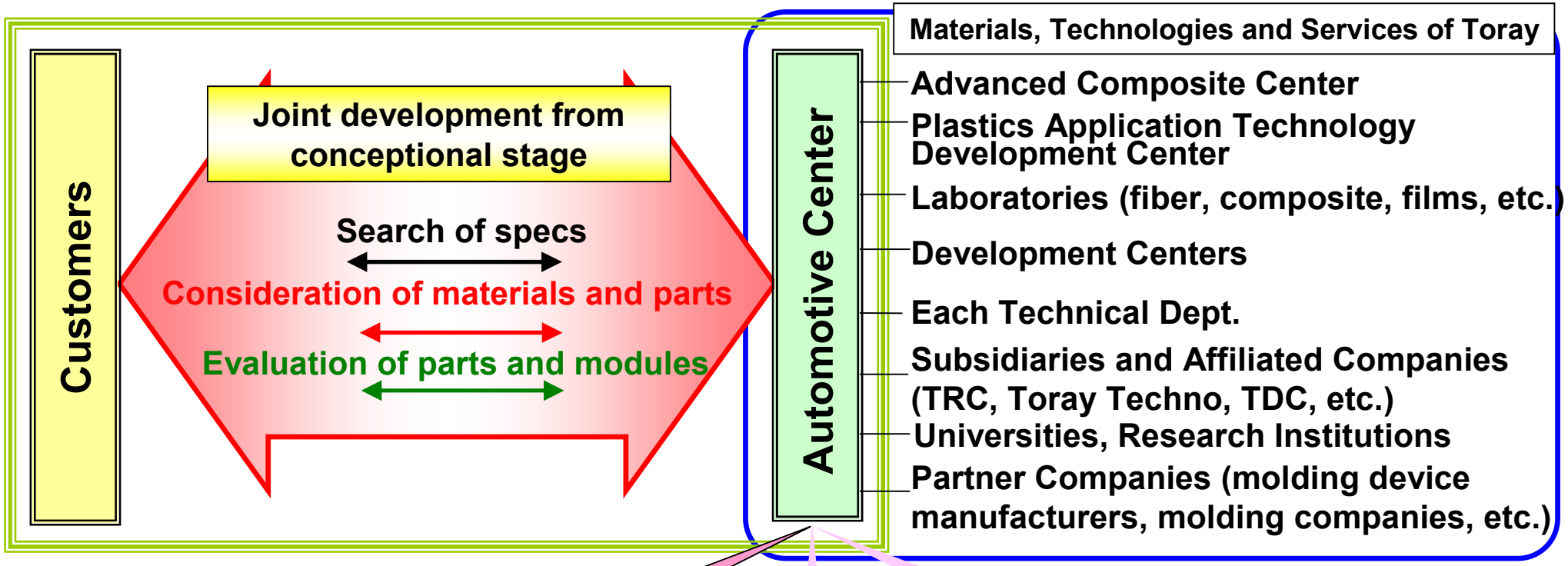
Collaboration

Research laboratories, Development centers, Each technical depts., Affiliated companies

Operation Concept and Function of Automotive Center

"TORAY" Innovation by Chemistry

■Participation from the customer's planning and conceptional stages for joint development toward shared targets.
■Offering solutions that fuse together Toray's materials, technologies and services.



■Three major functions of Automotive Center

Joint development
Management of joint projects with customers.

Technology Development
Development of automotive polymer material evaluation, analysis, molding and processing technologies

Information transmission
Acquisition and transmission of fresh automotive technology news, organization of technical seminars

Characteristics of the Automotive Center

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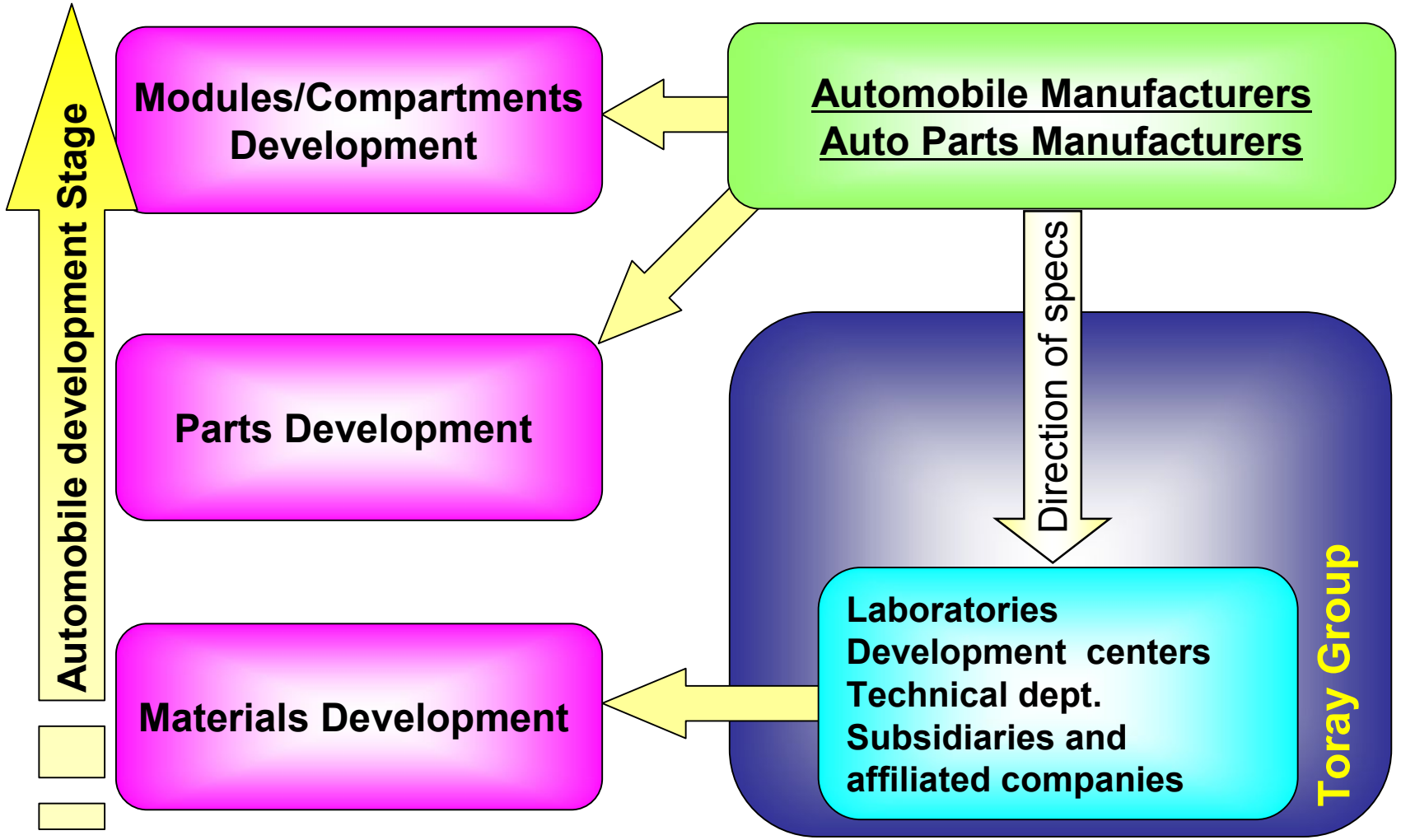
■Conventional development style
Materials manufacturers specialize in material developments (spec-in business)



Characteristics of Automotive Center

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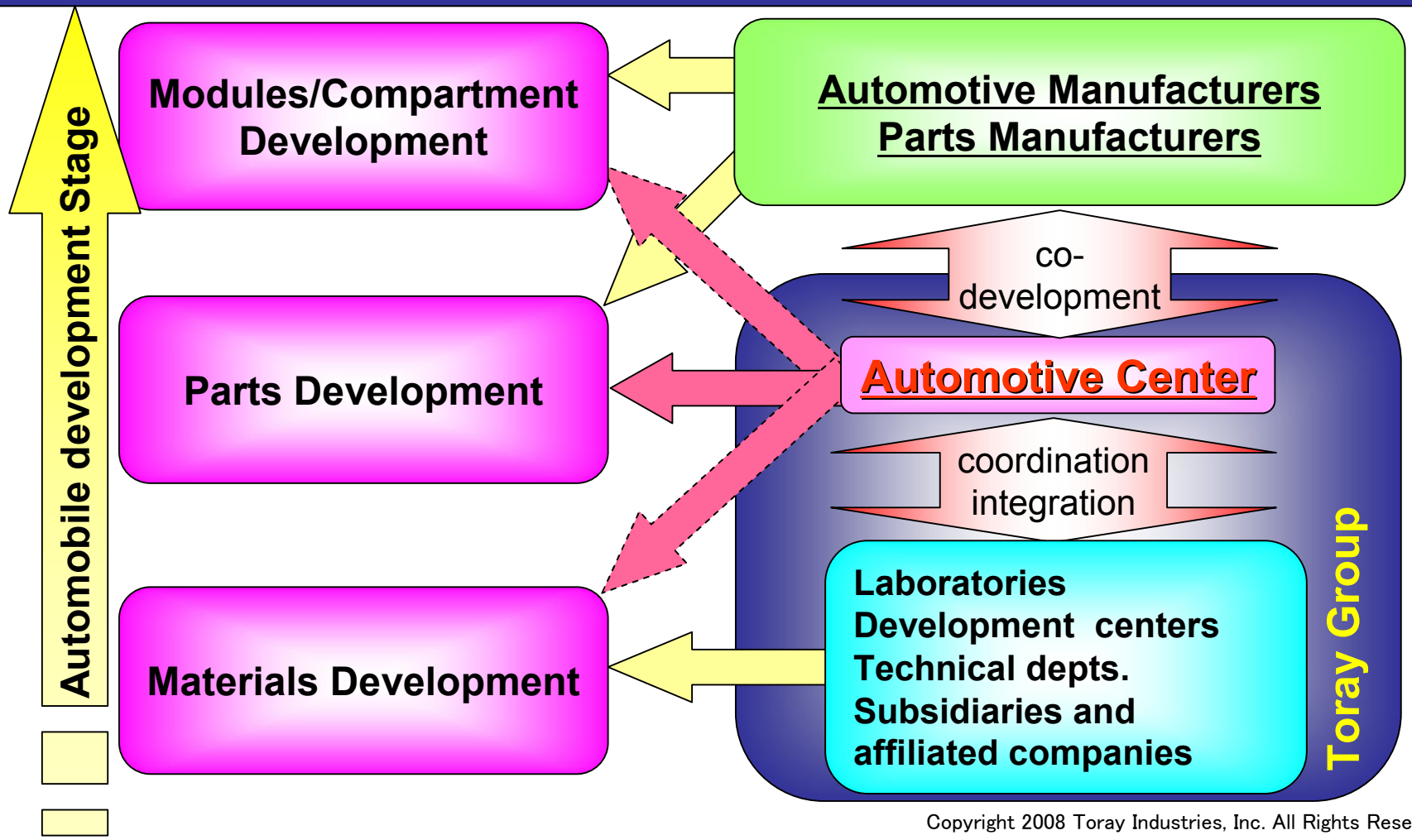
■Development style in Automotive Center
Coordination and integration of various technology resources of Toray Group
Joint developments of parts and units with customers through evaluation and analysis technologies as Parts.



Main Issues (Four Major Themes) of Automotive Center and Toray's Strength

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Theme 1. Weight Saving

Target parts: Panels, Main structural parts (chassis), etc.
Toray's strength : CFR thermoplastic, Film decorating, CAE technology.

Theme 2. Materials for Next Generation Power Train

Target parts: Motor, Secondary battery, etc.
Toray's Strength: High thermal stability films, Functional nano particles.

Theme 3. Non-petrochemical materials

Ecodeal エコディア

Targets parts: Fibers and textiles for interior and exterior parts
Toray's strength : Bio-based plastics, its fibers and films, etc.

Theme 4.Car Electronics

Target parts: Display, Sensor parts, etc.
Toray's strength : PDP, Polyimide resins, etc.

Application of Carbon Fiber Reinforced Plastics (CFRP) to Automobiles

"TORAY"
Innovation by Chemistry

CFRP＝Carbon Fiber Reinforced Plastic

Improvements using CFRP parts

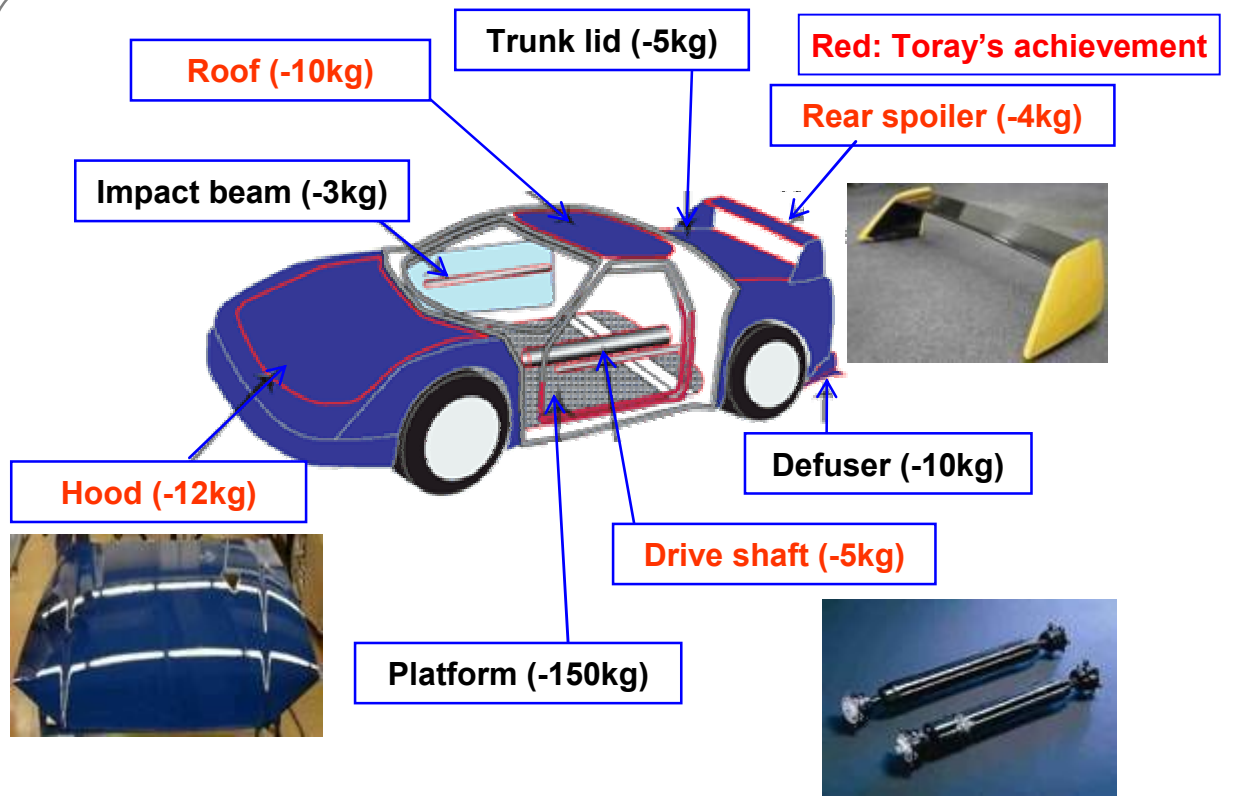
Weight Saving
Improvement of fuel efficiency
Global warming countermeasure

Improvement of crash safety
(High Impact energy absorption)

Improvement of driving performance
Improvement of vibration damping / natural frequency UP

Reduction of Assembly processes and cost
Modular Construction

CFRP Applications and its effect on weight saving



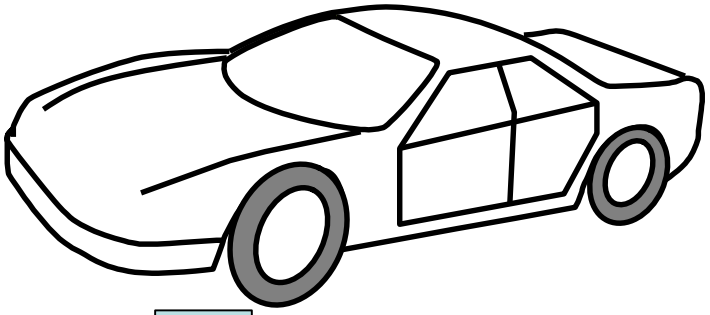
Possible to reduce 400kg using CFRP parts (30% of car body weight when the car weighs 1,380 kg)

Others (-200kg)
Door panel
Front end module
Seat back
Fender ,etc.

Examination of applicable parts of CFRP (Thermoset resin base and thermoplastic base)

'TORAY'
Innovation by Chemistry

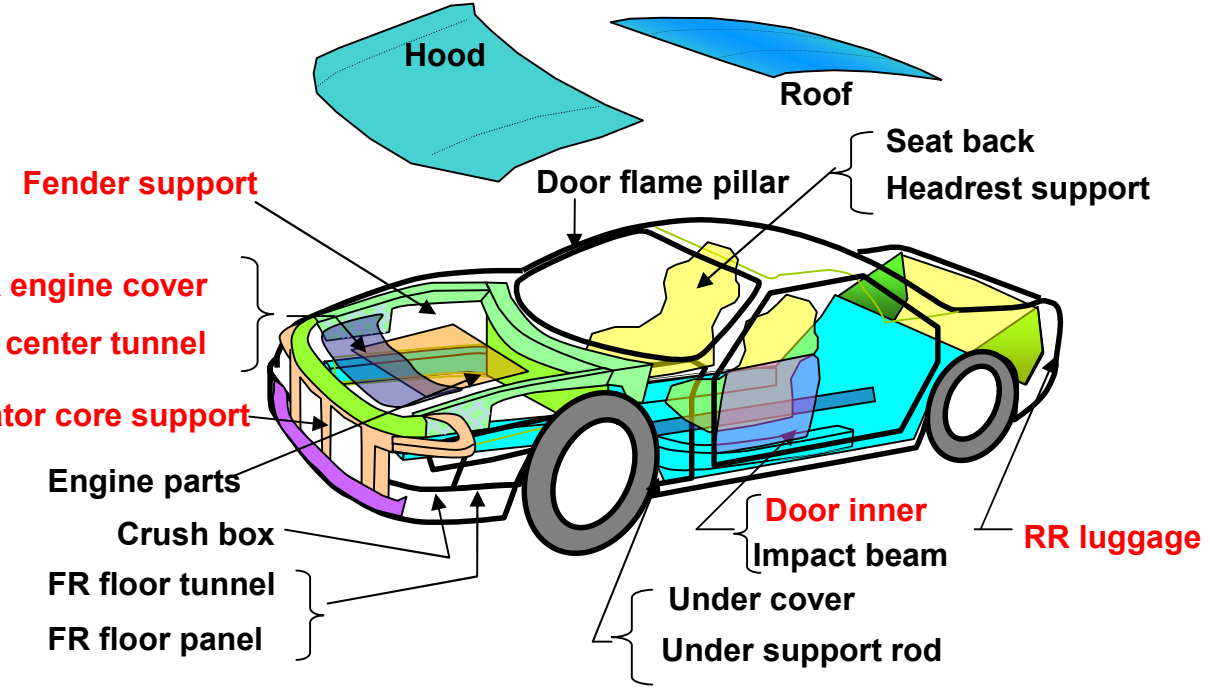
Average weight of conventional car : 1,380kg



CFRP

Weight of car with CFRP : 970kg (▲30%)

CFRP (Thermoset resin) (RTM molding)
Panels, Structural parts (30% the weight of steel)
CFRP (Thermoplastic) (Injection / Press molding)
Interiors, 2nd structural parts, Electronic parts (50% the weight of steel)



■New CFRP (thermoplastic) for high performance parts (complicated shapes), common parts (mass productivity) will be performed

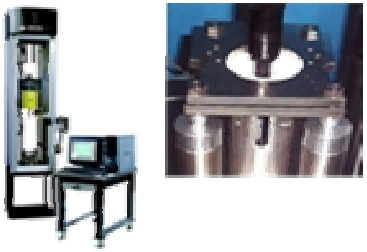
Facilities to Solve Technical Issues of CFRP (Thermoplastic)

TORAY
Innovation by Chemistry

1. Improvement of material reliability (Dynamic properties and Durability)

①Impact resistance - scattering stone, car crash, pedestrian protection

Charpy impactor



Weight-drop impactor

Head impact facilities

②Durability, weather resistance- hygrothermal resistance, long-term outdoor exposure, thermal shock, etc.

Large constant temperature and humidity chamber

Xenon weather meter

Large thermal shock chamber

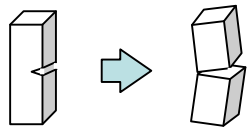
Evaluation of Impact Resistance

'TORAY'
Innovation by Chemistry

①Impact resistance

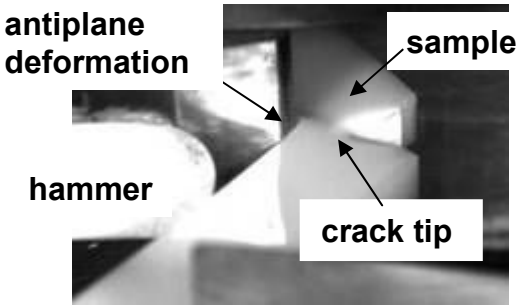
- Various impact evaluation facilities for testing specimens and automotive parts (To construct databases for impact resistance and failure behavior of plastic materials)
- Estimation of impact strength and failure behavior as car parts with combination of CAE technologies to reduce time and labor.

Observation of failure mechanism



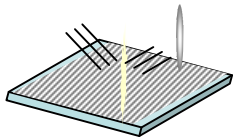
10 × 60 mm

Charpy impactor



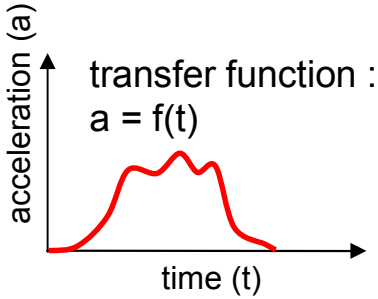
Charpy test (shot by high speed camera)

Nondestructive evaluation



80 × 80 mm

Weight-drop impactor

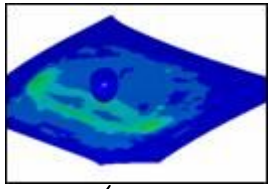


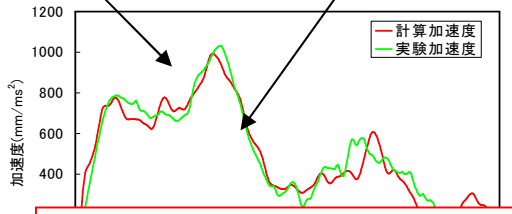
CAE

Large parts

2,000 × 2,000 mm

Test facilities for pedestrian protection





To confirm compatibility of analysis with examination

Evaluation of Durability

'TORAY'
Innovation by Chemistry

②Weather resistance / Long-term durability

■Confirms material reliability of new polymer materials for car parts

Evaluation facilities for test specimens

Long-term weather resistance (ultraviolet degradation)

Long-term light resistance

Xenon weather meter

Long-term heat stability

Absolute dry properties

Perfect oven

Evaluation facilities for large scale parts

Large constant temperature and humidity chamber

Long-term hygrothermal stability

Water absorbed properties

Thermal shock chamber

Thermal shock properties

High / low temperature aging properties

Improvement of Surface Quality (painting and film decorating)

TORAY
Innovation by Chemistry

2．Improvement of surface quality

①Painting performance – coated properties, coating strength, improvement of surface quality

Robotic painting equipment

Digital gonio photometer

Surface roughness meter

②Film decorating technology – development of new plastics / films materials

Film laminating machine

Vacuum molding machine

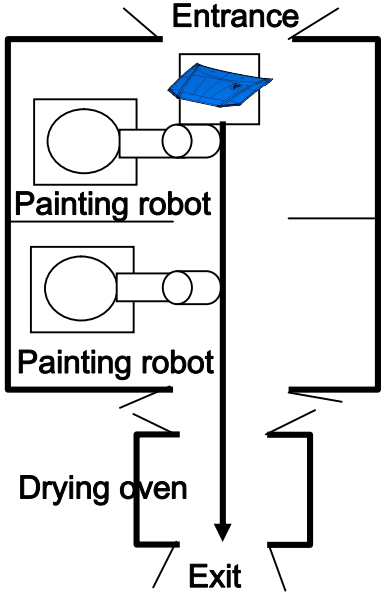
1000t injection molding machine

Improvement of Surface Quality (painting)

'TORAY'
Innovation by Chemistry

①Painting performance – coated properties, coating strength, surface quality

■Development of suitable materials for various paints and panting processes and optimization of painting conditions



Paint booth (outline)

Painting robots

- **Main specification :**
  maximum painting area : 1700×1700 mm
  maximum drying temperature : 140 ℃

Painting durability evaluation

Larger thermal chock chamber

Large constant temperature and humidity chamber

Painting quality evaluation

Variable Gloss Meter
(Plastics Application Technology Development Center)

Digital Gonio photometer (AMC)

Surface roughness meter
(Plastics Application Technology Development Center.)

Improvement of Surface Quality (film decorating)

TORAY
Innovation by Chemistry

②Film decorating technology (high quality / designing surface) , paint-less)

■Offering new surface appearance and design which is suitable for polymer materials

Film processing

Trimming

Trimmer

Maximum process width : 600 mm

Printing

Semiautomated serigraph

Maximum printing area : 600×600 mm

Laminating

Film laminating machine

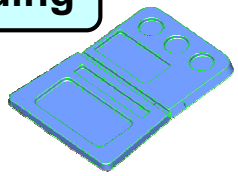
Maximum process width : 600 mm

Film insert molding

Preforming

Vacuum molding machine

Insert molding



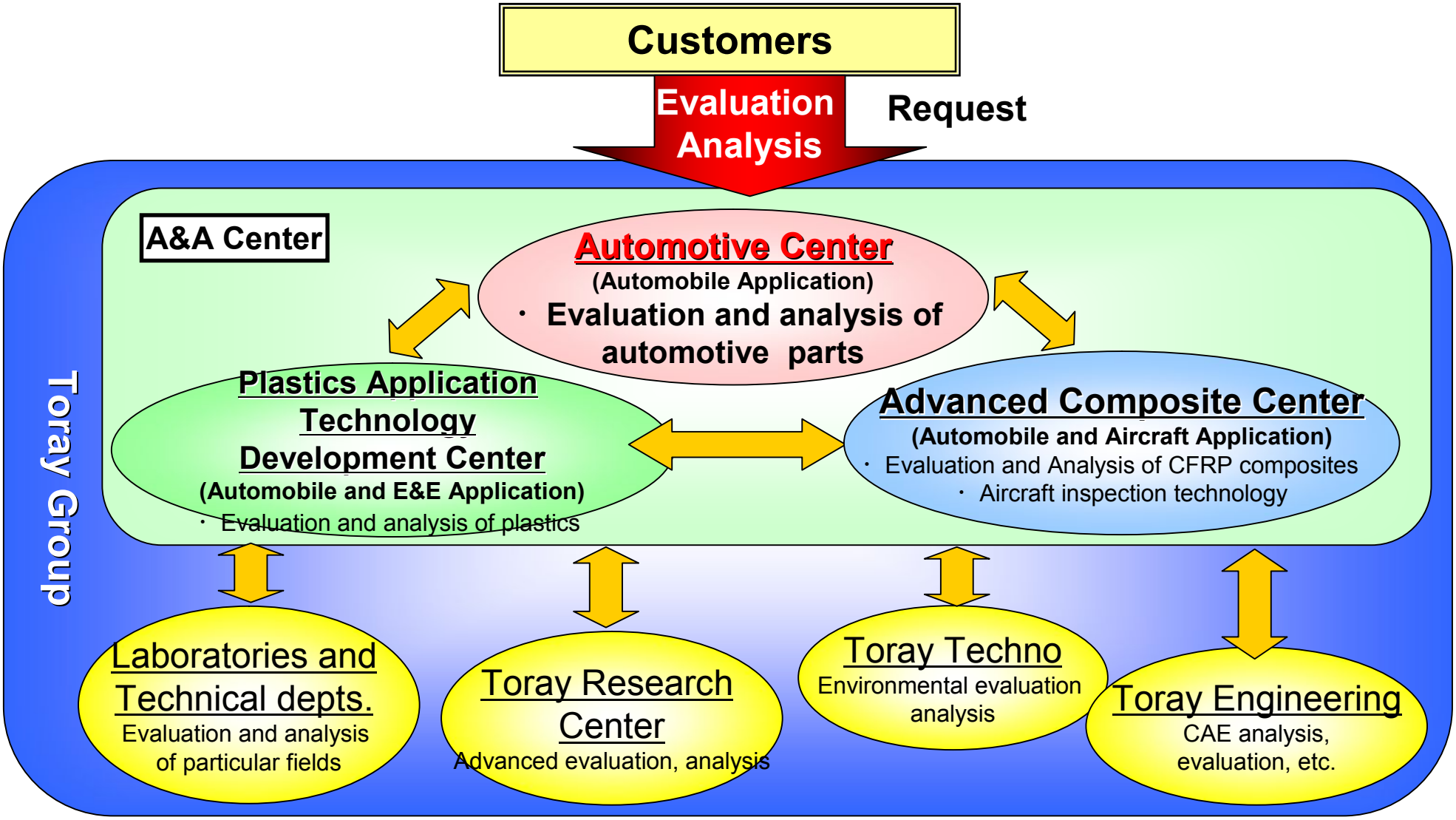
1000 ton injection molding machine

Evaluation

- Film adhesive strength
- Surface roughness, brilliance
- Heat stability, durability (long-term /short-term)

Evaluation and Analysis System of Automotive Center and Toray Group

"TORAY"
Innovation by Chemistry

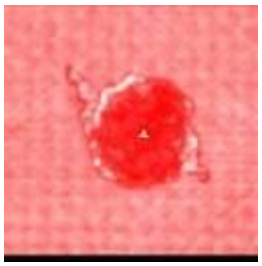


■Realization of various supports through utilization of technological resources in Toray Group

Application of Aircraft Inspection Technologies

TORAY
Innovation by Chemistry

■Application of inspection technologies for aircraft materials
■Estimation of strength and lifetime of parts by Nondestructive.



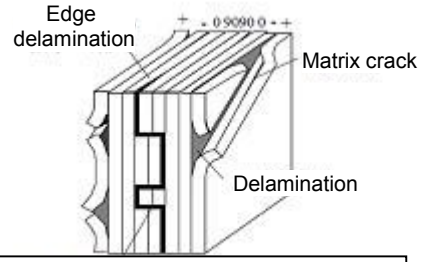
Ultrasonic C-scan

Observation of defects within the material and measurement of damage level

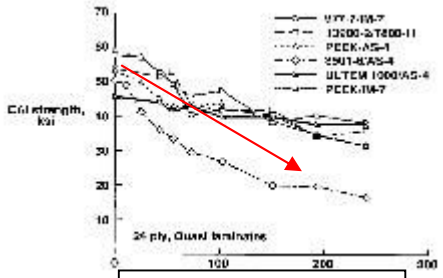
3D X-ray scanner

Observation and measurement of orientation angle and distribution of fibers

Ex. Relation between CFRP internal defect and strength



Specific fracture pattern of composite material



Large defects on invisible defect

◆The other inspection and analysis facilities in Toray group◆

Hydraulic fatigue machine (AMC)
Creep machine (AMC)
High speed impact machine (Plastics Application Technology Development Center)
DSC/DMA (Plastics Application Technology Development Center)
3D shape measurement equipment (ACC)

Application of aircraft development technologies in automobile fields

Battery and Electrode Evaluation and Analysis Technology (Toray Research Center)

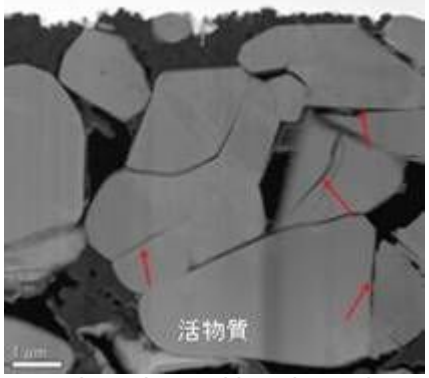
"TORAY"
Innovation by Chemistry

■Estimation and Improvement of performance of battery and electrode by shape observation, composition and structural analysis

Lithium-ion battery

Morphological analysis, composition and structural analysis of positive/negative-electrode materials
Thickness and composition analysis of electrode membranes (SEI membranes)
Composition analysis and additives and trace impurities analysis of battery electrolytes , etc.

TEM observation of $LiCoO_2$ positive electrode after repeated charge and discharge cycles



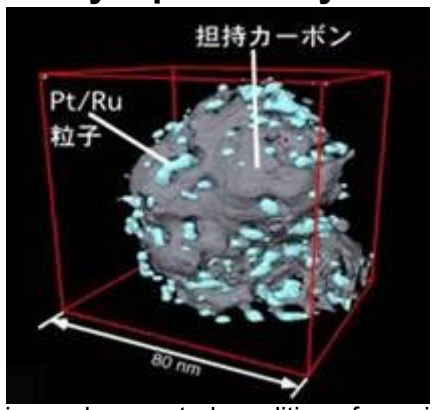
Cracks occurred on the positive electrode materials by deterioration of long-term usage. On the surface of positive electrode particles, Co changed to the conditions like metal

Realization of high capacity, Improvement of cycle properties, and Improvement of safety

Fuel cell

Structural analysis and property evaluation of electrolyte membranes
Structural and composition analysis of catalyst particles
Composition analysis and trace impurities analysis of battery electrolyte, etc.

Observation of supported condition of a catalyst particle by 3D TEM



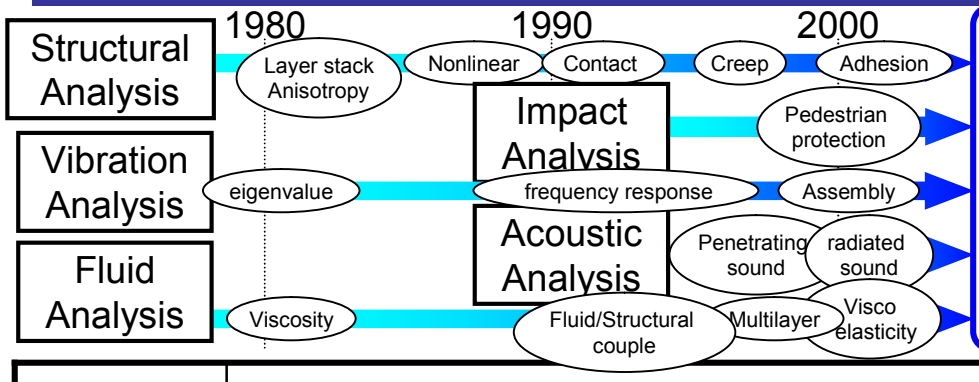
Particle size and supported condition of nm size catalyst particles can be observed in three dimensions.

Solution of deterioration mechanism (Improvement of durability)
Reduction of Pt usage (Cost reduction)

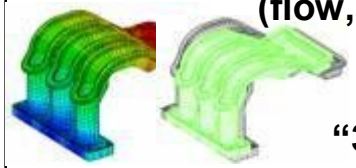
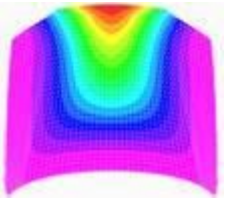
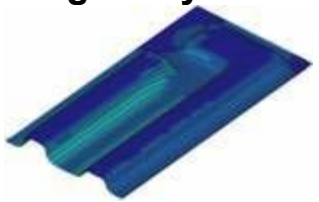
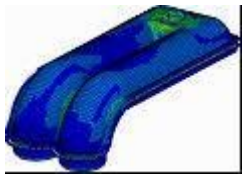
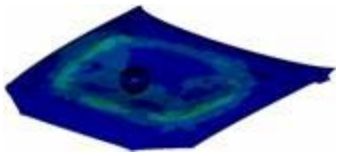
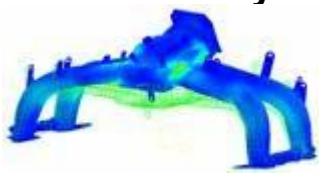
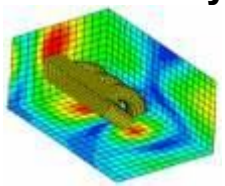
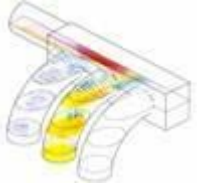
CAE Technology for Automobile Application

'TORAY' Innovation by Chemistry

- Toray has started R&D of CAE technology since 1970s and has developed several fields of CAE technologies for polymer materials
- Toray has started design support for customers using CAE analysis since 1980s. (total 4,000 cases)
- Based on combination of CAE analysis and various test evaluation technologies and databases, performance and quality of end products can be estimated.



CF Composite field
Design support for customers' end products
50 cases / year, total sum over 500 cases (1990 ~)
Plastic field
Design support for customers' end products
250 cases / year, total sum over 3,600 cases (1980 ~)
Software Businesses (TEK)
Injection Molding CAE "3D TIMON"
Total sum of sales 250 companies, 450 sets (1980 ~)

Item	Materials		
	Plastics	Composites	Films
Injection field	Injection Molding Analysis (flow, warpage) "3D TIMON" 	RTM Molding Analysis (Resin flow) "VAR-TIMON" 	Vacuum Molding Analysis (film setup) 
Analysis field	Structural Analysis  Impact Analysis 	Vibration Analysis  Acoustic Analysis 	Fluid Analysis 

CAE Technology for Automobile Application

TORAY Innovation by Chemistry

■Support of design for customers' product from an early development stage, cooperation of each dept., utilization of CAE technology
→ Design and Development time / Experimental evaluation cost can be reduced
■ Many achievements of co-development and design support for automobile manufactures and auto parts manufactures

CAE development and support system

Customers

Automotive Center

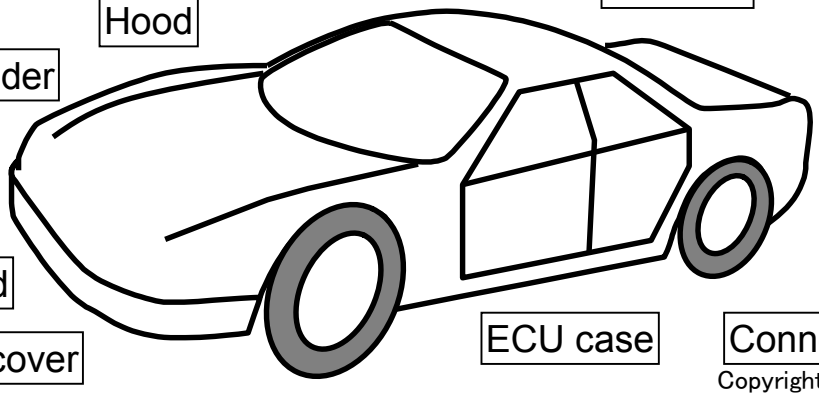
Engineering Development Center
・CAE elemental technology development
・Customer design support

Advanced Composite Center
molding / design / evaluation analysis of composite materials

Plastics Application Technology Development Center
molding / design / evaluation analysis of plastics

Toray Engineering Co., Ltd.
Development and sales of injection molding CAE software "3D TIMON"

Main CAE application parts



Roof
Trunk lid
Rear spoiler
Hydrogen tank
Hood
Fender
Pillar reinforcement body
Fuel tank
Front end module
Instrument panel
Shift lever base
Engine cover
Power module
Intake manifold
ECU case
Connector
Cylinder head cover

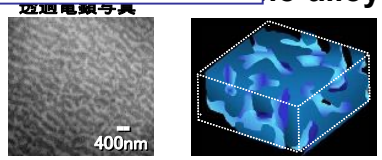
Automotive Center's Function of Collection and Transmission of Information

"TORAY"
Innovation by Chemistry

- Introduction of timely Toray Group's advanced materials and technologies (molding, processing, evaluation, analysis, etc.)
- Collection of new information from customers, universities, companies.

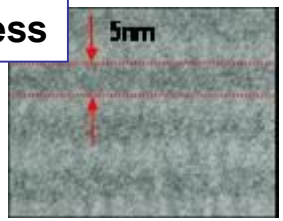
Toray Group's Advanced Materials and Technologies

New material



Nano controlled new materials

Process

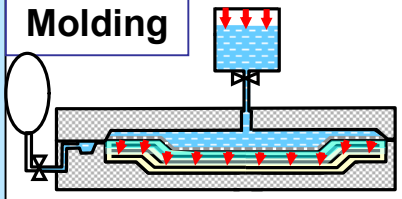


New materials by nano processing technology

Analysis

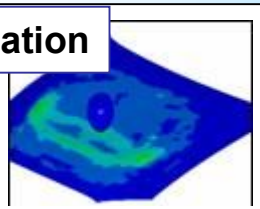
Property evaluation and analysis technology

Molding



New molding technologies of new materials

Simulation



Proposal of analysis method of new materials

Information Transmission
Technology seminar
New technology display
Library display

Information Collection
Academic information
Market information
Innovative technology

Customers

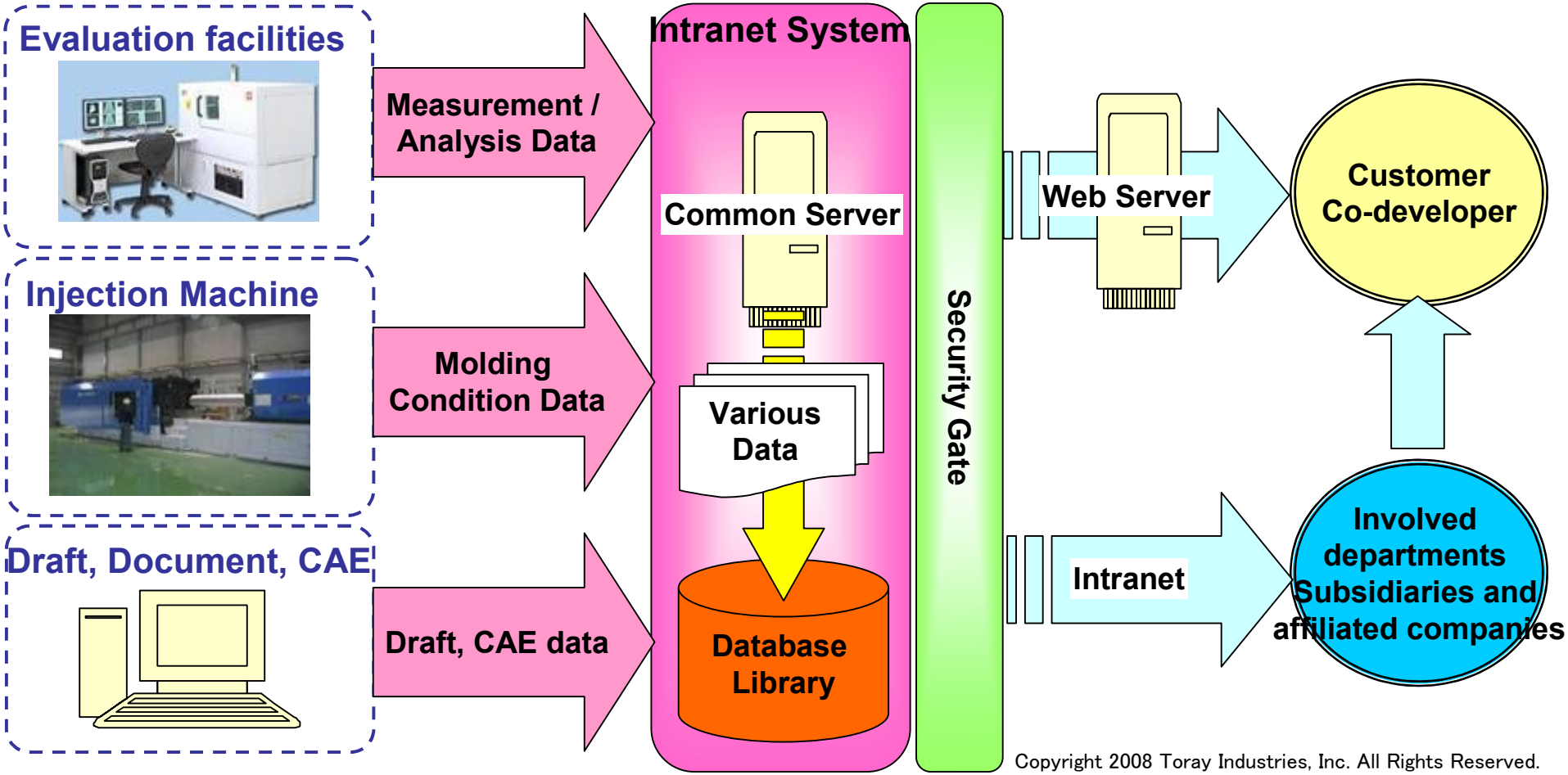
Partner Companies

Universities, National laboratories

Automotive Center's Function of Collection and Transmission of Information ~ DB Library, IT ~

"TORAY"
Innovation by Chemistry

- Collection of measurements of evaluation / molding machines online and Construction of databases
- Establishment of the library which selected / combined / integrated multiple data
  → Promptly search and offer materials data which meet customers' and internal relevant departments.



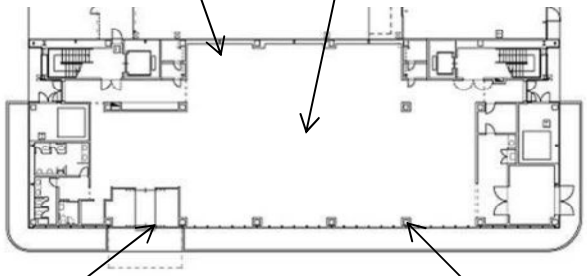
Outline of Automotive Center's Facilities <Gallery, Conference Room>

"TORAY"
Innovation by Chemistry

◆Main Building 1F (Display Lobby)

Themes Display Area

Materials Display Area



Entrance

New Technology Display Area

◆Main Building 2F
(Conference Room, Seminar Room)

TV Conference Room (30 people capacity)

Seminar Room
(80 people capacity)

CAE room

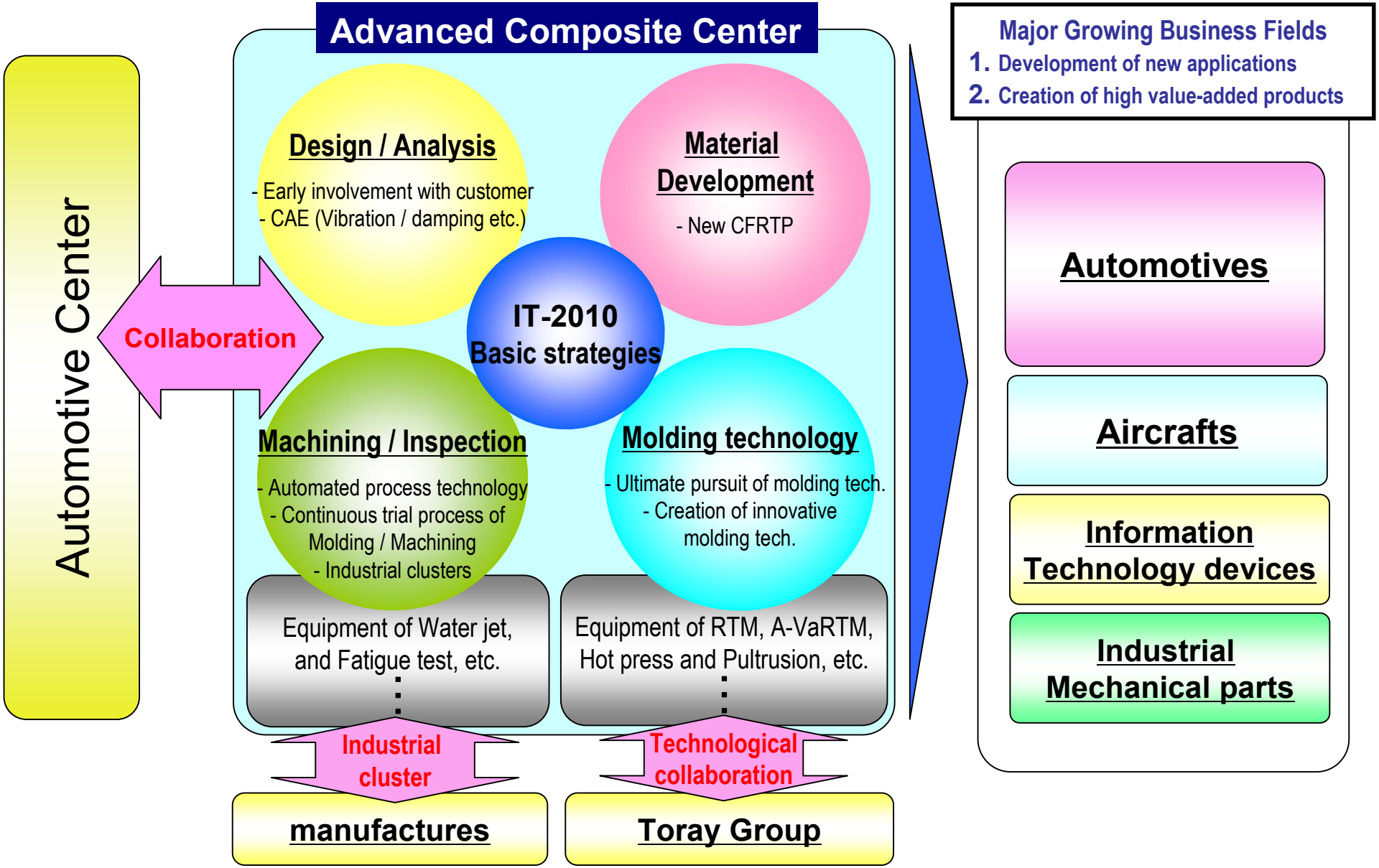
Others

2 small
conference rooms
with 15 people capacity
1 medium
conference room
with 30 people capacity
1 reception and
conference room
with 10 people capacity


TORAY
Innovation by Chemistry
Advanced Composite Center

Development Functions of Advanced Composite Center

'TORAY'
Innovation by Chemistry



Major Development Functions of Advanced Composite Center

"TORAY"
Innovation by Chemistry

■Acceleration of innovative technologies creation and mass-production technologies establishment by reinforcing molding / evaluation equipments.

Technologies	Major equipments
1. Material development / Evaluation	Mechanical property test, Fatigue test DMA
2. Design technology	CAD CAE
3. Molding technology	RTM, Autoclave Injection molding
4. Machining / Inspection technology	Water jet 3-dimension measurement

Automotives : Establishment of continuous development / trial-production system for materials, design, molding and machining

1. Creation of design/molding/machining technologies : To develop new applications and expand composite materials business
2. Creation of new materials and deepen molding technologies : To expand materials business and enhance technical support functions

Strategies for Composites Business

TORAY
Innovation by Chemistry

Area	Major applications (Now going)	Expansion and New Plans
Energy-related  Fuel cell stack	・Fuel cell (electrode gas diffusion layer) ・Wind turbine (small wind-turbine blades)	・**Fuel cell (electrode gas diffusion layer)** ・**High-pressure vessel**
Transport machinery 	・Automotive propeller shaft ・Exterior panels (sports car)	・**Automobile propeller shaft/ Exterior panels** ・**Automotive structures** ・**Aircraft structures**
Civil engineering and Construction 	・Bridge railings ・Seismic retrofitting (bridge pier, deck slabs, buildings (beams, columns)) ・lightweight building structures (truss, roof structures)	・**Bridge railings**
Industrial equipments 	・Medical equipments (X-ray equipment) ・Information technology devices (Laptop PC case, etc.) ・Mechanical parts (Robot arms for LCD panel, etc.)	・**Information technology device (Laptop PC case)** ・**industrial robot**

'TORAY'

Innovation by Chemistry

Expansion Strategy of Automotive Materials Business

Toray Industries, Inc.

Senior Director

Automotive Material Strategic Planning Dept.

Kazumichi Ebisutani

Contents

- Toray Group's Involvement in the Automobile Industry
- Environment and Issues surrounding the Automobile Industry
- Expansion Strategy of Automotive Business

Contents

- **Toray Group's Involvement in the Automobile Industry**
- **Environment and Issues surrounding the Automobile Industry**
- **Expansion Strategy of Automotive Business**

Toray Group's main materials and technologies for Automobiles

'TORAY' Innovation by Chemistry

【Fibers and Textiles】

Fiber and fabric for airbags, tire cord, fabric and man-made suede for car seats, cabin filter, etc.



【Resins & Chemicals】

Resins for automotive parts
(ABS, Nylon, PBT, PPS, LCP)
Polyolefin foam for interior and exterior



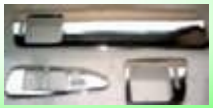
【Carbon Fiber Composite Materials】

Hood, Roof, Propeller shaft, Spoiler, Impact beam, etc.



【Films】

Films for capacitor, motor insulation and decorating and process films

【Electronic & Information】

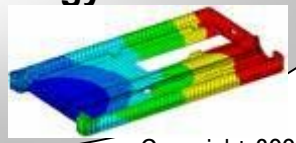
LCD color filter, Optical fiber, Polyimide film for FPC



【Technical Support for Customers' Design , Processing Technologies/Facilities】

Toray Research Center Inc. (analytical evaluation technologies),
Toray Engineering Co., Ltd. (process technology and CAE analysis) , etc.





~ Toray Group's Involvement in the Automobile Industry ~

Adoption Examples of Toray Group's Materials for Automobiles

"TORAY"
Innovation by Chemistry

Under Food Parts


Engine cover


Intake manifold


Injector


Oil filter


CHC


Oil reserve tank

Mechanical and Functional Parts


Seat belt


Air bag


Tire cord


Lamp reflector


Door rock


Accelerator pedal


Shift lever base

Exterior and Interior Decorating Parts


Seat


Roof surface


Radiator grill


Instrument panel


Wheel cover


Spoiler

Cooling and Fuel System


Radiator tank


Cooling fan


Barrier layer for fuel tank


Water inlet


ORVR valve


gasoline sub tank

Electric component


ABS-ECU


Ignition


Lamp Socket


Connector


Power window switch


Rotation sensor


Electronic throttle sensor housing


Alternator parts


Neutral starter

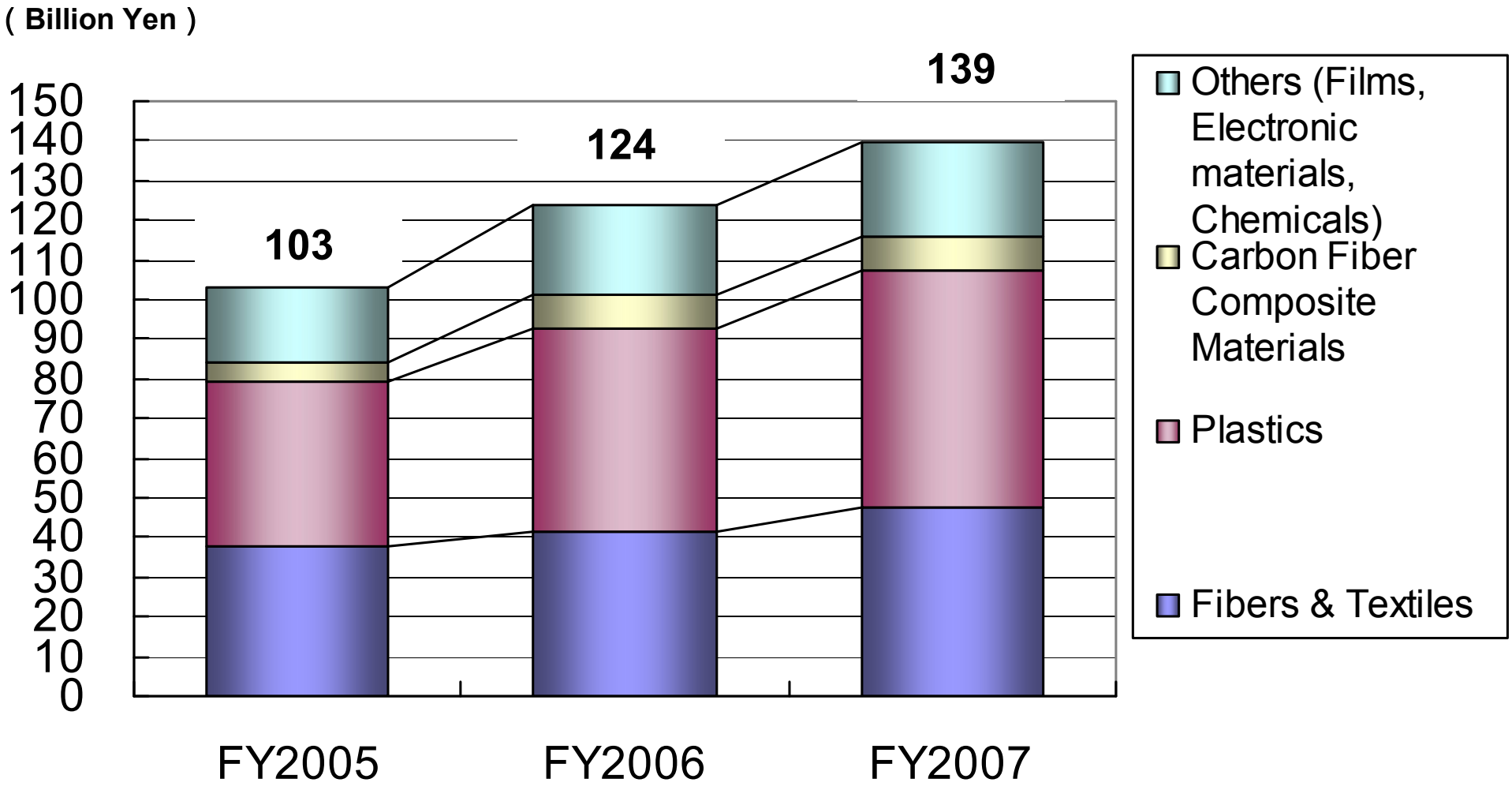

Lever combination switch


Relay box


Power seat motor

Toray Group's Sales for Automobiles

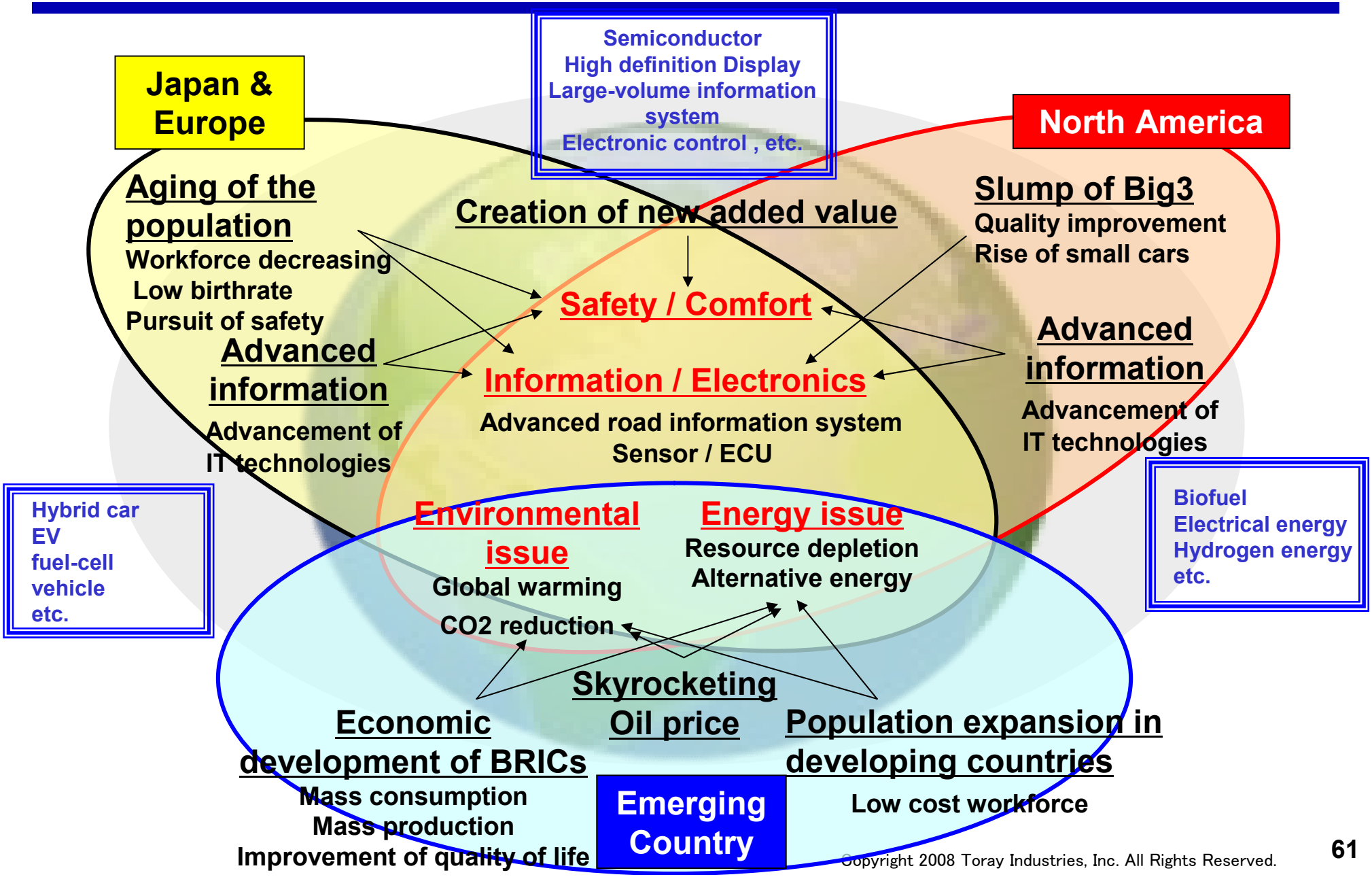
TORAY
Innovation by Chemistry



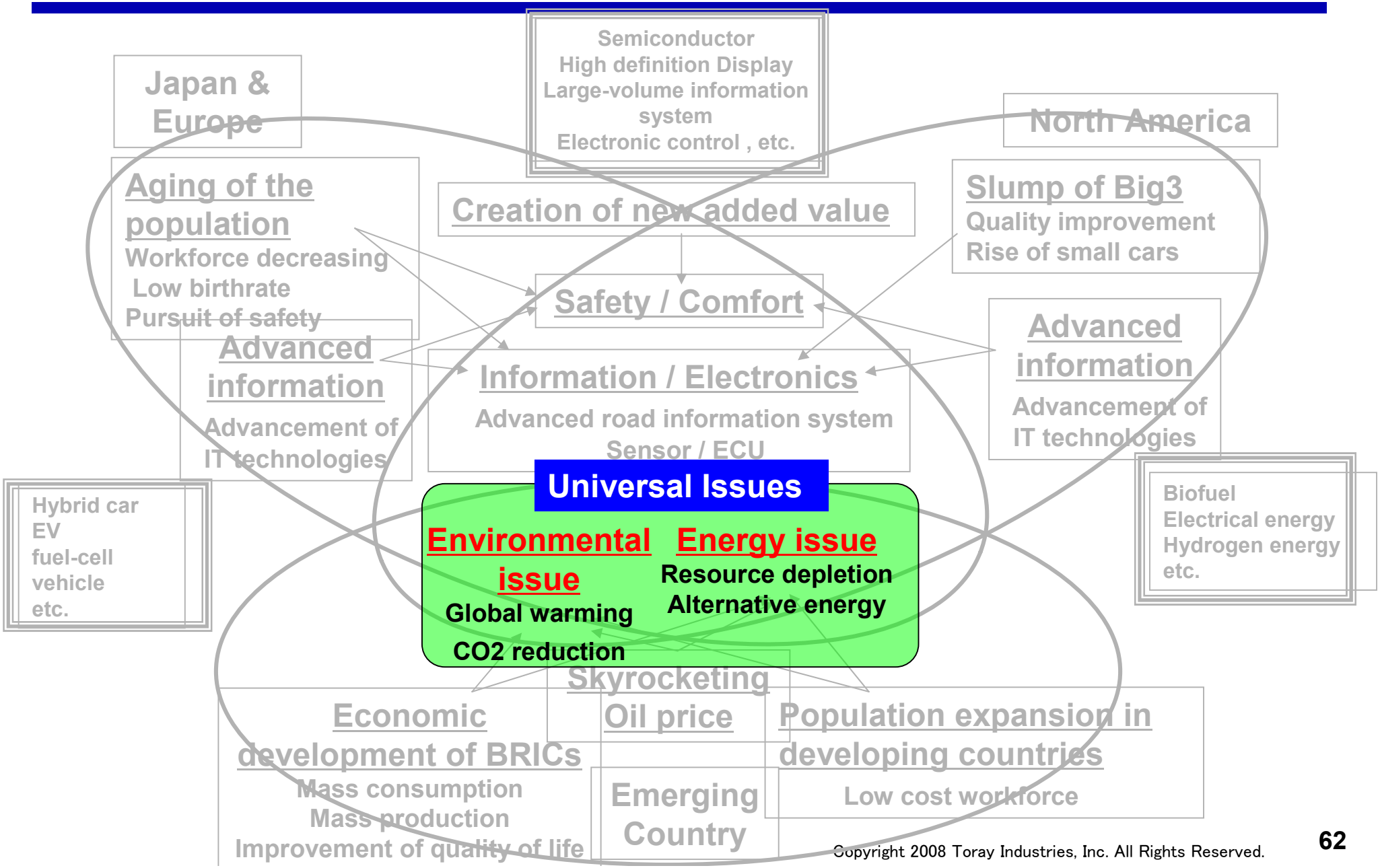
Contents

- Toray Group's Involvement in the Automobile Industry
- **Environment and Issues surrounding the Automobile Industry**
- Expansion Strategy of Automotive Business

Market Changes in the Automobile Industry



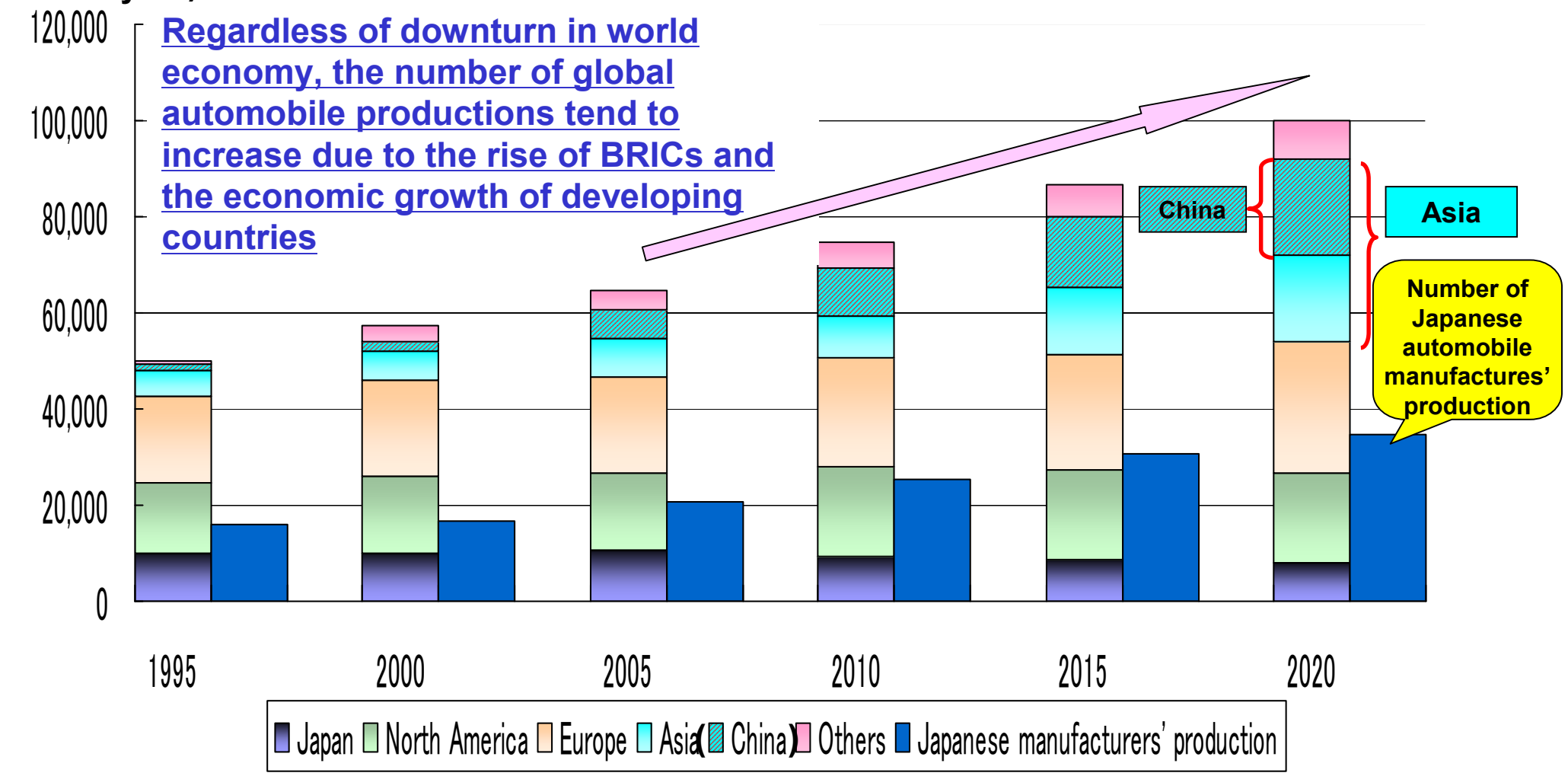
Market Changes in the Automobile Industry



Number of Automobile Production

TORAY
Innovation by Chemistry

Number of Global Automobile Production



(Estimated by Toray based on the data of Japan Automobile Manufacturers Association, Inc. and FOURIN, Inc.)

~ Environment and Issues surrounding the Automobile Industry ~

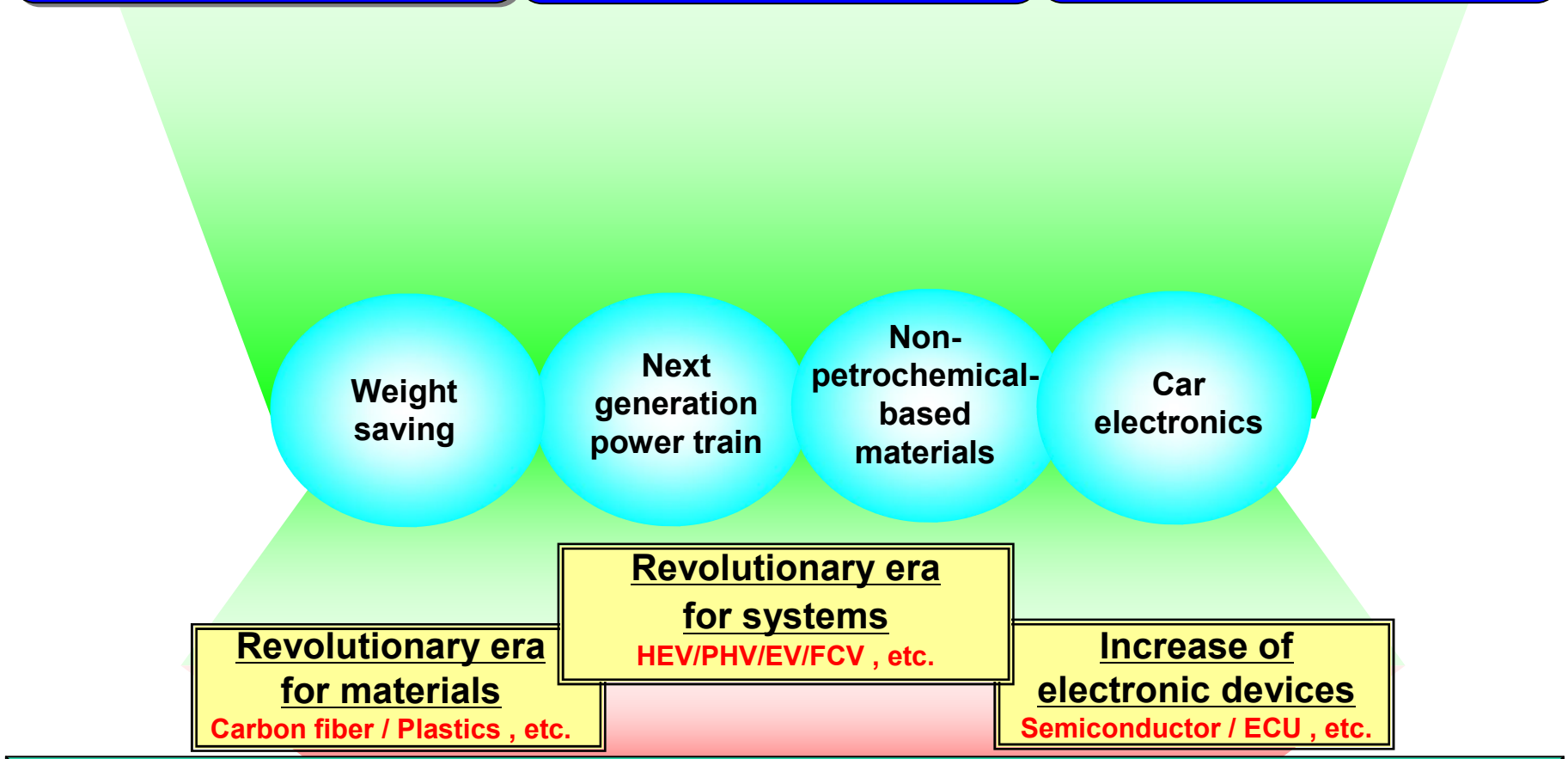
Revolutionary Era of the Automobile Industry

'TORAY'
Innovation by Chemistry

Environment / Energy
CO2 reduction
Alternative energy , etc.

Safety / Comfort
Pre-crash safety system
relax / comfort, etc.

Information / Electronics
Advanced road information system
Electronic control / sensor, etc.



Toray contributes to the automobile industry by advanced materials and technologies

Contents

- Toray Group's Involvement in the Automobile Industry
- Environment and Issues surrounding the Automobile Industry
- **Expansion Strategy of Automotive Business**

~ Expansion Strategy of Automotive Business ~

Main Items for Expansion of Automotive Business

"TORAY" Innovation by Chemistry

Issues of the automobile industry

- Safety / Comfort
- Environment / Energy
- Information / Electronics

Toray's Innovation

Integration of materials
Integration of materials such as fibers, plastics, films, carbon fiber composite materials, etc.

Organic Synthetic Chemistry
Polymer Chemistry
Nanotechnology
Biochemistry

Advanced Materials / technologies
Nanotechnology-based innovative materials, Low environmental load materials, Innovation materials of semiconductor / circuit, Next generation display, Nano control structure, Nano fabrication, New polymer materials, Green chemistry , etc.

Weight saving
:Roof, Hood, Quasi-structure material, etc.


Next generation power train :
Motor, Secondary battery, etc.


Non-petrochemical-based materials :
Interior

Ecodeal エコディア


Car electronics : Display , Electronic component, Sensor, Semiconductor, etc.


~ Expansion Strategy of Automotive Business ~

Revolution of the Automobile Industry and Toray's Response

"TORAY" Innovation by Chemistry

◆Advancement of Weight Saving | ◆Diversification of power trains | ◆Expansion of application of Nonpetroleum-based materials | ◆Car electronics

Trend of the automobile industry

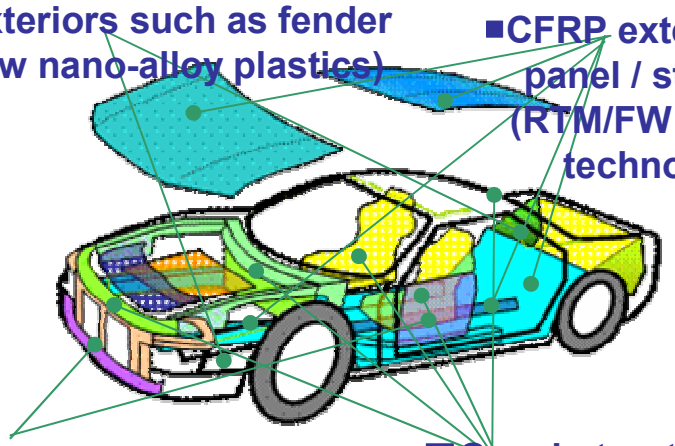
Automobile manufactures established weight saving projects and consider expansion of application of light weight materials such as high-tension steel, aluminum, plastics, carbon fiber composite materials, etc.

Weight Saving Project of Automobile Manufacturers

	Project	Goal
Toyota	Mass Innovation	Weight▲10% by 2011 (Midsize sedan)
Honda	Set by each car type	Weight saving goals are not explicitly shown (CO2▲10% by 2010)
Nissan	Vision 2015	Weight▲15% by 2015 (Average weight)
Mitsubishi	CLW30	Weight▲30% by 2010

Toray's strategy and corresponding materials and technologies

○Advances development of high performance plastics with nano-alloy
○Expands application of carbon fiber composite materials
○Integrates plastics and carbon fiber composite materialas



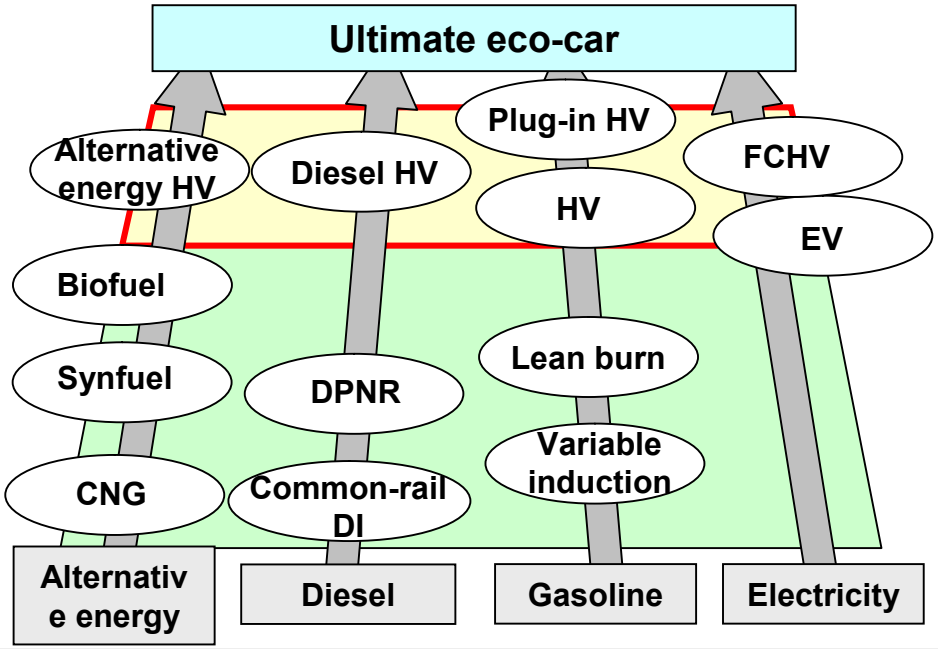
Revolution of the Automotive Industry and Toray's Response

◆Advancement of Weight Saving | ◆Diversification of power trains | ◆Expansion of application of Nonpetroleum-based materials | ◆Car electronics

Trend of the automobile industry

○Automobile manufactures advance developments of several approaches such as clean diesel, alternative energy, HV, plug-in HV, electricity, fuel cell, etc.

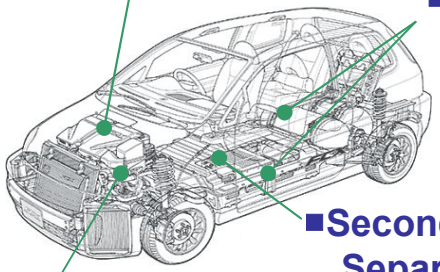
○HV core technologies such as power module, motor, secondary battery, etc. are applicable to all approaches.



Toray's strategy and corresponding materials and technologies

○Advances materials for HV/EV core parts such as motor, secondary battery, etc.

○Expands materials for fuel cells



■Power module
Capacitor (PP film)
Case, Inverter (PPS resin)

■Fuel cell
Hydrogen tank,
Electrode base material
(Carbon fiber composite materials)

■Secondary battery
Separator (heat resistance film)
Case, Plate (PPS resin)

■Motor insulator
(PPS resin, PET/PPS film)

■*Common issues for cars*
Weight saving (carbon fiber composite materials/plastics)

Revolution of the Automotive Industry and Toray's Response

"TORAY" Innovation by Chemistry

◆Advancement of Weight Saving | ◆Diversification of power trains | ◆Expansion of application of Nonpetroleum-based materials | ◆Car electronics

Trend of the automobile industry

- Toyota already adopted non-petrochemical-based materials for several parts.
- Other manufactures are also advancing the development of parts with non-petrochemical-based materials.

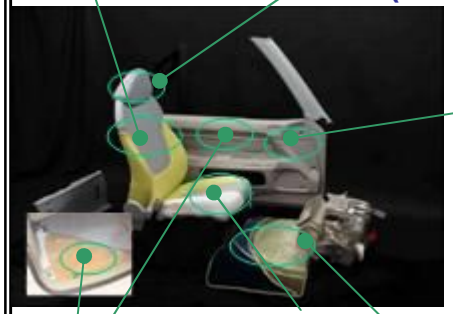
Toyota's applications

option mat

spare tire cover

Toray's strategy and corresponding materials and technologies

- Expand applications of interior and exterior parts with non-petrochemical-based fibers, plastics and films
- Utilize advanced technologies such as nanotechnologies and new processing methods and advance improvement of properties, which is an issue to adopt non-petrochemical-based materials



car seat surface (FY textured yarn)

head rest materials (SF lamination)

plastics for exterior/interior, decorating films (nano-alloy, plant fiber reinforced)

Seat cushion material (SF lamination)

Spare tire cover /trim (kenaf/PLA-SF board)

option mat (BCF+PLA nonwoven fabric)

Revolution of the Automotive Industry and Toray's Response

◆Advancement of Weight Saving | ◆Diversification of power trains | ◆Expansion of application of Nonpetroleum-based materials | ◆Car electronics

Trend of the automobile industry

○Car electronics become diversified to advance comfort with car navigation, large-volume information system, etc. and to improve safety with ABS, brake assist, millimeter-wave radar, etc.

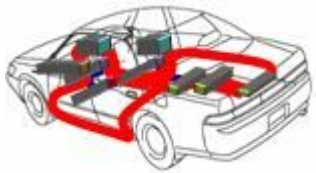
○Car electronics corresponding to throttle control, engine control, HEV, EV, FCV advance.

Toray's strategy and corresponding materials and technologies

Expand applications of advanced materials and technologies such as display, semiconductor materials, electronic circuit materials, high performance films, which have been cultivated in IT fields, into automobiles.

■LCD meter, In-car display such as car navigation, etc. (Color filter, Organic EL-related materials, etc.)

■Large-volume information system (Plastic optical fiber)



■Sensors, Semiconductors (High performance resin, Next generation resist, Semiconductor packaging circuit board, etc.)

~ Expansion Strategy of Automotive Business ~

Automotive Material Strategic Planning Dept.

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Automotive Material Strategic Planning Dept.

Corporate Marketing Planning Dept.
Corporate Strategic Planning Dept.

Fibers & Textiles Division

Resins & Chemicals Division

Films Division

Subsidiaries and Affiliated Companies of Toray Group

Technology Center

Electronics & Information Related Products Division

Torayca & Advanced Composites Division

Strategic Promotion Conference of Automotive Material

* Decision of sales expansion, planning and investment between divisions
* Total optimization and information unification
* Backup of each development theme

routine work
+
Obtainment of customers' customer information and peripheral information

- Representative window of Toray Group
- Information gathering through direct contact with customers
- Search of new development themes and needs
- Proposal of solutions by Toray Group's comprehensive ability

routine work
+
Obtainment of customers' customer information and peripheral information

Automobile manufacturers / Auto parts manufacturers

Automotive Material Strategic Planning Dept. and Automotive Center

Each dept.
(Fibers & Textiles, Plastics, Films, Torayca & Advanced Composites, Electronics & Information Related Products, etc.)

Each related technical dept.
(Fibers & Textiles, Plastics, Films, Carbon fiber related, Electronics & Information related, etc.)

Automotive Material Strategic Planning Dept.

Automotive Center

Companies in Toray Group
(TI, TRC, TEK, TDC, DCT, etc.)

Utilization of comprehensive ability

Integrated development with customers

Advanced Material Technology
Polymer Chemistry
Nanotechnologies and alloy
Fine Chemical

Advanced Processing Technology
High level processing technology
of fibers and textiles, films
Plastic molding technology
Innovative composite molding
Bonding technology

Technical Support for Customer's Design
CAE analysis technology
Analytical evaluation technologies
Reliability and Durability assessment

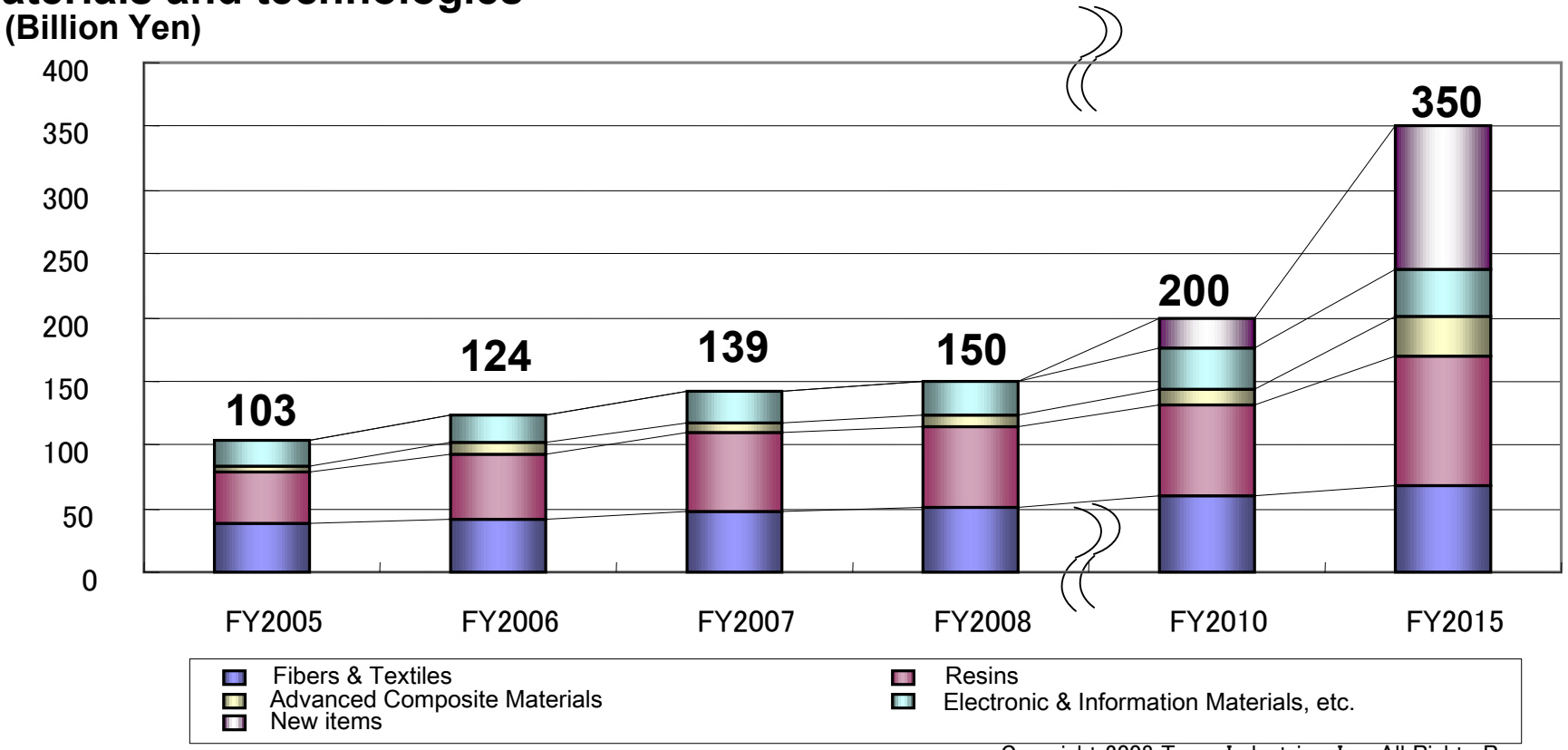
Creation by comprehensive ability

- Sharing of target
- Cooperative design and material selection
- Cooperative evaluation

Response to Revolution of the Automobile Industry

Expansion Target of Automotive Materials Business

- ◆Expand sales of materials which Toray currently holds by making them high performance and high added-value.
- ◆Create new items which response to environment / energy, safety, comfort, car electronics with materials used in other applications, material integrations, advanced materials and technologies.
- ◆Help the automobile industry contribute to global environment with advanced materials and technologies



Descriptions of predicted business results, projections and business plans contained in this material are based on assumptions and forecasts regarding the future business environment, made at the present time.
The material in this presentation is not a guarantee of the Company's future business performance.