Toray’s R&D Strategy
- Focus on Advanced Materials based on Nanotechnologies -

Koichi Abe
Vice President
General Manager, R&D Division
Toray Industries, Inc.

December 7, 2007
Toray Group is the comprehensive manufacturer, which develop advanced materials by using core technologies such as “Organic Synthetic Chemistry”, “Polymer Science”, “Nanotechnology” and “Biotechnology”, and have international operations.

Consolidated Net Sales:
¥ 1,546.5 billion (FY Mar/07)

Consolidated Operating Income:
¥ 102.4 billion (FY Mar/07)

Established: Apr. 16, 1926
Consolidated basis: 21 countries & regions, 36,553 employees (as of Mar/2007)
Road Map to IT-2010 and Targets in IT-2010

Long-term Corporate Vision

AP-New TORAY 21

Corporate Slogan
CORPORATE BRAND

AP-Innovation TORAY 21

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%

Images in and around 2015
Net sales ¥2,300 billion
Operating income ¥230 billion
Operating income to net sales ratio 10.0%
ROA : \( \geq 10\% \)
ROE : \( \geq 12\% \)

Mid-term Business Strategies

“NT21”
- Corporate Structure Reinforcement
- Offensive management postures
- Breakaway from Crisis

“NT-‡”
- Management based on Innovation and Creation
- Establish foundation for further growth

“IT-2010”
- Challenges for further growth

Toward a Global Top Company of Advanced Materials

Goals in and around 2010

April 2002
April 2006

2004
2006
October

Around 2010

Around 2015
IT-2010 • R&D Innovation

R&D Reform

Progress in Advanced Materials Projects
- New optical films, Organic Electro luminescent-related Materials, Chemical Mechanical Polishing Pads, Next-generation high density COF, PLA Film, High-performance DNA Chips, etc.

Leap forward

R&D Innovation

“Challenge for Innovative R&D”

“Strengthen R&D Collaboration & Integration”

Step forward

R&D Reformation - II

“Depart from Independent R&D”

Innovation of Technologies
- Advanced Material Businesses Expansion PJ
- R&D capabilities innovation PJ
- Manufacturing technology innovation PJ
As a fundamental material manufacturer based on science & technology, Toray Group is developing original high level advanced materials & technologies.
★ One of TC functions is deciding corporate R&D strategies and designating TC important projects.
★ The most valuable feature of TC is that it functions as organizing Toray’s R&D as one unit, not to be divided into small R&D unit attached to each business unit.
R & D Expenditure & Personnel (consolidated)

★ R&D Expenditure : ¥ 47 Billion (2007 planned)
★ ¥ 240 Billion of R&D investment planned in 5 years from FY 2006
Strengthening R&D Activities in China

TFRC: Toray Fibers & Textiles Research Laboratories (China) Co., Ltd.

Basic Concept
- R&D meshed seamlessly with Toray (Japan)
- R&D activity by high-level Chinese researchers
- Promoting collaborations with Chinese universities and government research laboratories
  → utilizing open labs (Shanghai Jiao Tong University, etc.)
- R&D and technical support for Toray’s businesses in China
- Developing of global R&D human resources

Personnel Plan (TFRC)

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>March/02</td>
<td>10</td>
</tr>
<tr>
<td>July/07</td>
<td>~ 210</td>
</tr>
<tr>
<td>Mar/08</td>
<td>~ 260</td>
</tr>
</tbody>
</table>

Organization

Nantong R&D Center
- (Established Mar/02)
- (Expanded May/05)
- (Expanded Oct/07)

Shanghai Branch Labs
- (Established Oct/04)

Nantong R&D Center
- Textiles R&D Dept.
  - Polymerization Research of Polyester
  - R&D of Fibers
- Polymer Materials Research Lab.
  - Research for polymer advanced materials
  - Research for electronics related materials & Pharmaceutical
- Water Treatment Research Lab.
  - R&D of Water treatment technology
  - Technical support for Toray’s businesses in China

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Toray R&D Strengths

Advantages

1. Culture and history that create innovative technologies: *Attach importance to Basic Research*
2. Various kinds of specialists groups in many fields
3. Unified R&D structure
4. Leading company in academia/industry / government collaboration
5. Advanced analytical capabilities: TRC

Technology Integration

Original Technologies

- Nano-alloy
- High Purity CNT
- Membrane Bio-process
- Carbon Fiber Composite Materials
- Innovative Polymerization Process
- etc.

Business Network

- Fibers & Textiles
- Films & Film Products
- Chemicals
- Composite Materials
- Electronic & Imaging Materials
- Global Environment
- Pharmaceuticals
- New Frontiers
- Specialty Materials
- Research Labs.
- Fibers & Textiles Research Labs.
- Films & Film Products Research Labs.
- Chemicals Research Labs.
- Composite Materials Research Labs.
- Electronic & Imaging Materials Research Labs.
- Global Environment Research Labs.
- Pharmaceuticals Research Labs.
- New Frontiers Research Labs.
- Specialty Materials Research Labs.

Core Technology

- Organic Synthetic Chemistry
- Polymer Science
- Biotechnology
- Nanotechnology

Technology Integration

- IT and Electronics
- Automobiles and Aircraft
- Life Sciences
- Environment, Water and Energy
- Affiliated Companies
- Torayca & Advanced Composites
- Electronics & Information Related Products
- Pharmaceuticals & Medical Products
- Water treatment & Environment
- Resins & Chemicals
- Films

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Basic Research has changed the World

Carbon Fibers (thousand tons/year)

- Started Research of CF (1961)
- Started full-scale Commercial Production of CF (1971)
- Adopted as Secondary Structures of B737 (1975)
- Adopted as Fishing Rods (1972)
- Adopted as Golf Shafts (1973)
- Selected as Primary Structures of B777 (1989)
- Started Project of B787 (2003)

Amount of CF: 30 tons/aircraft

B787

B777

Amount of CF: 7 tons/aircraft

Industry Applications

Aircraft & Aerospace Applications

Sporting Applications

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Toray R&D Strengths

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Original Technologies

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Core Technology

- Organic Synthetic Chemistry
- Polymer Science
- Biotechnology
- Nanotechnology

Business Network

- Fibers & Textiles
- Resins & Chemicals
- Films
- Torayca & Advanced Composites
- Electronics & Information Related Products
- Pharmaceuticals & Medical Products
- Water treatment & Environment
- Affiliated Companies

Technology Integration

Fibers & Textiles Research Labs.
Films & Film Products Research Labs.
Chemicals Research Labs.
Composite Materials Research Labs.
Electronic & Imaging Materials Research Labs.
Global Environment Research Labs.
Pharmaceuticals Research Labs.
New Frontiers Research Labs.
Specialty Materials Research Labs.

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Fusion Theme Planning Project (STAR Project)

**STAR Project**
- Locate strategically prioritized areas
- Cooperate among laboratories from the planning stage of the themes
- Promote WG activities consisted of experts of each laboratory

**Example of Achievements:**
- Epoxy nano-alloy for composite materials
- Nano-alloy technologies (Chemicals Research Laboratories)
- CFRP technologies (Composite Materials Research Laboratories)

- Potentially applicable to wide-ranging areas including weight-saving of aircraft, crash safety of automobiles, impact resistance, and vibration absorption characteristics.
Toray R&D Strengths

1. Culture and history that create innovative technologies: *Attach importance to Basic Research*
2. Various kinds of specialists groups in many fields
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4. Leading company in academia/industry/government collaboration
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Advantages

- Technology Integration

Original Technologies
- Nano-alloy
- High Purity CNT
- Membrane Bio-process
- Carbon Fiber Composite Materials
- Innovative Polymerization Process

Core Technology
- Organic Synthetic Chemistry
- Polymer Science
- Biotechnology
- Nanotechnology

Business Network
- Fibers & Textiles Research Labs.
- Films & Film Products Research Labs.
- Chemicals Research Labs.
- Composite Materials Research Labs.
- Electronic & Imaging Materials Research Labs.
- Global Environment Research Labs.
- Pharmaceuticals Research Labs.
- New Frontiers Research Labs.
- Specialty Materials Research Labs.

Fibers & Textiles
- Resins & Chemicals
- Films
- Torayca & Advanced Composites
- Electronics & Information Related Products
- Pharmaceuticals & Medical Products
- Water Treatment & Environment
- Affiliated Companies

IT and Electronics
- Automotive and Aircraft
- Environment, Water and Energy
- Life Sciences

Innovative Polymerization Process
- etc.
Guiding principle: Contributing to the industrial world through advanced technologies
Corporate mottoes: To provide advanced and reliable technology and to strictly observe complete confidentiality (Technology & Trust)
Business contents: Contract research on analysis and materials evaluation, Technical surveys, Contract research and development
Establishment: 1978, Jun. (Number of employee 500 2006)

TRC’s Proven and Comprehensive Technological Expertise
- Chemical Structure Analysis
- Surface Analysis
- Organic Analysis
- Materials Characterization and Evaluation
- Morphological Studies
- Pharmaceutical and Life Sciences
- Inorganic Analysis
- Environmental Analysis and Energy
- Contract Research Services
- Publication of Research Reports
### Toray's Challenge for Technology Innovation

#### Pattern for Success
- Innovation by Chemistry
- Toray's Core Technology

#### Major Fundamental Technology
- New Materials
- Nano-materials
- Biotechnology
- Nano-process

#### Four major growing business fields
- IT & Electronics
- Automobiles / Aircrafts
- Life Sciences
- Environment / Water-related / Energy

- Allocating approximately 90% of R&D resources to four major growing business fields (2007)

#### APEX 40
- Allocate R&D resources to APEX 40 (top priority 40 themes)
Toray’s R & D Strategy
Toray. Making the winning play at 1/1,000,000,000 of a meter.

Technology that accurately controls matter at the atomic level. Using nanotechnology, Toray is creating new value in a variety of fields. For advanced materials that will redefine the future. Toray’s Nanotechnology.

Toray Nanotech commercial message (on the air in Japan from October 2007)
Toray nanotech R&D is the source of keen interest and anticipation

Toray ranked as top company to watch in nanotech field!

Nihon Keizai Shimbun newspaper “Companies to Watch This Year” survey, 2005

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Name</th>
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<tbody>
<tr>
<td>1</td>
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<td>2</td>
<td>Toyota Motor Corporation</td>
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<td>3</td>
<td>Mitsubishi Chemical Corporation</td>
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<td>4</td>
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<tr>
<td>5</td>
<td>NEC Corporation</td>
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<td>Canon, Inc.</td>
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<td></td>
<td>Showa Denko K.K.</td>
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<td>8</td>
<td>Shin-Etsu Chemical Co., Ltd.</td>
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<td>9</td>
<td>Toshiba Corporation</td>
<td>45</td>
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<tr>
<td>10</td>
<td>Matsushita Electric Industrial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asahi Kasei Corporation</td>
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<tr>
<td></td>
<td>Toyota Central R&amp;D Labs, Inc.</td>
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Nikkei Nano Business magazine “Companies to Watch This Year” survey, 2007

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<td>5</td>
<td>Asahi Kasei Corporation</td>
<td></td>
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<tr>
<td>6</td>
<td>FUJIFILM Corporation</td>
<td>11</td>
</tr>
<tr>
<td>7</td>
<td>Teijin Limited</td>
<td>10</td>
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<tr>
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<td></td>
<td>Kao Corporation</td>
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<td></td>
<td>Olympus Corporation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JSR Corporation</td>
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</table>

Based on the motto that, “Innovative Products Only Come with Innovative Materials”, Toray has utilized chemistry as the focus of its pursuit of technological innovation, integrated with nanotech and other Toray core technologies to spearhead the challenge into the creation of advanced materials.
Nano-co-continuous Alloy

We created the new technology for the first time, using the nanotech field, which combines two different types of polymers (into alloys), while bringing out the outstanding properties of both polymers. We started to market nano-alloys for use in automobile parts, electrical and electronic components and other injection molding applications, developing transparent sheets, decorative film and other new applications. This technology is also being applied to polylactide alloys, taking advantage of these inherent properties for moving into electrical and electronic fields in which it was difficult to put conventional polylactide to work.

- **Applications**
  - Injection molding items: Balance competing properties for high impact resistance of PC and high chemical resistance of PBT.
  - Films, sheets: Balance competing properties for the high transparency of PC and high chemical resistance of PBT.

**Nano-ally Structure**

**Performance Comparison**

- Nan-alloy Structure
  - Injection molding items: Balance competing properties for high impact resistance of PC and high chemical resistance of PBT.
  - Films, sheets: Balance competing properties for the high transparency of PC and high chemical resistance of PBT.
Topics of Advanced Materials

Information/Telecommunications/Electronics

Flexible Solar Battery

Semiconductor, Circuit Materials
Display Materials (LCD)

**LCD Composition Example**

- Polarizer
- Glass
- Color Filter
- LCD
- Retardation film
- Luminance improvement film
- Diffusion film
- Prism sheet
- Reflective film
- Fluorescent tube
- Light guide plate

**High-performance reflective film**

- Toray existing film (PET + olefin)
- New product
  - Super-fine olefin dispersion
  - Realized world-class brightness

**Colorless aramid film**

- Existing film (colored)
- New product (transparent)

<table>
<thead>
<tr>
<th>Property</th>
<th>PC</th>
<th>PES</th>
<th>Colorless aramid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorless and transparency</td>
<td>○</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Heat resistance</td>
<td>×</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Strength</td>
<td>△</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Coefficient of thermal expansion</td>
<td>×</td>
<td>△</td>
<td>○</td>
</tr>
<tr>
<td>Moisture absorption</td>
<td>○</td>
<td>○</td>
<td>△</td>
</tr>
</tbody>
</table>

- Young's modulus (GPa)
- Glass transition temperature (℃)

**New product**

- PES
- PC
- PEN
- Cyclic-polyolefin

**Ink-jet LCF**

- Material (Toray)
- Equipment (TEK)

- Ink-jet head
- RGB ink
- Pigment nanodispersion
- Ink-repulsive black matrix
- Nozzle coating method equipment design

**Toray Group all-out efforts**

- Super-fine olefin dispersion
- Realized world-class brightness

**Comparison with: standard sheet**

- Incremental brightness (cd/m²)
  - Existing film
  - New product

- Nano-alloy PET + Specific olefin
Display Materials (PDP)

PDP Structure

Toray Photosensitive Paste Barrier Ribs Formation Technology

1. Fewer number of processes and high productivity
2. Good variance of shapes
3. Fine processing

Development of Barrier Rib Materials for Ultra-fine PDP

W-VGA, W-XGA
(400,000~1 million pixel)

Full HD
(2 million pixel)

4k2k*
(8 million pixel)

* corresponding to next generation TV

Explore possibilities for the development of other electronic component applications
Display Materials (Organic LED)

Organic LED Structure and Toray-developed Materials

- Technological integration of organic synthetics and nano-tech (nano-dispersion technology)
- Red light emissive materials: Industry leader in color purity / luminescent efficiency = (Host + Dopant)
- Electron transport materials: Industry leader with low driving voltage (power-saving)

Deepening of technology

1. Highly-efficient / long-life blue materials
2. Common electron transport layer
3. Low driving voltage hole transport layer

Promote de facto standard through the development of materials ①•②•③

★ Aim to be a comprehensive organic LED material manufacturer (market size of 2011: 30 billion yen)

Comparison of luminescent performance

- Durability: 20,000 hrs or more *
- * under 1000cd/㎡

Low driving voltage effect

Better

0.5μm

0.62 0.64 0.66 0.68

Luminescence efficiency (cd/A)

Luminescence: 10
Company B
Company A
Toray

Voltage (V)

Brightness (cd/㎡)

0 2 4 6 8 10

Alq: aluminum complex

Commodities

Electron transport material

Toray

Practical region in response to moving image

Voltage (V)

0 2 4 6 8 10

Brightness (cd/㎡)

0 100 200 300 400 500
Deepening and Expansion of Polyimide-coating Materials

Polymer Design Coating

PI: polyimide

Non-photosensitive PI

1981~

SEMICOFINE*

Coating for Semiconductor

Photosensitize + Alkaline developable

Negative-tone photosensitive PI

1981~

Thinner layer

Development of OLED applications

Light emitting

Active type
→ ~100%
Passive type
→ about 60%
Planarization layer
new material accepted

Insulator

2004~

Low outgass
Low taper angle

- outstanding planarity
- transparent

2007~

Low cure temperature (below 200°C)
- thick coating applicable
- low shrinkage
- high adhesion

Corresponding to next generation

World market leader (DRAM half pitch <90nm)

Low temperature processing + Thick coating

2000~

- high-sensitivity
- high dimensional accuracy
→ high resolution (5μm)
- outstanding chemical resistance
- high adhesion

Positive-tone photosensitive PI

2004~

- thin coating applicable
- resolution 10μm

Expected sales of polyimide coating materials: over 10 billion yen (2010)
New Electronics

Deepening and Expansion of Nano-multilayer Technologies

Objective: Development of innovative films with multilayer laminate technologies

Technology:
- High-precision multi-layer laminates
- Slant multi-layer laminates
- Film for optical communication (optical waveguide *)

Security films
- Tear resistance strength
- Average layer thickness

Metal-free metallic luster film
- High refractive-index polymer
- Low refractive-index polymer
- >800 layers

Further deepening...

※This research is partially aided by NEDO (New Energy and Industrial Technology Development Organization).

Organic Transistor Materials

Objective: Development of organic transistor materials having high performances comparable to amorphous silicon (target: mobility more than 1 cm²/Vs)

Technology:
- High mobility organic transistor materials by the use of organic semiconductor (OSC) and CNT-complex
  - Organic Semiconductors: unique molecular design / synthesis based on new concept / high solubility to conventional solvents (printable)
  - CNT dispersion: CNT-complex can be easily dispersed into OSC solution

Current status
- Mobility more than 0.5 cm²/Vs achieved by using CNT-complex and newly developed OSC

※※※
In Nagoya Plant, Toray will create “A&A Center (Automotive & Aircraft Center)”, an integrated technological development base for automobile and aircraft applications. As the first step, Toray will establish “Automotive Center (AMC)” for the development of technologies for automobile applications.

Sequentially establish production system for plastic resins, carbon fiber composite materials, and high performance chemical products for automobile and aircraft applications

“Automotive Center (AMC)” will be established in June/08

Toray will reinforce Nagoya Plant as an integrated technological development base of advanced materials applicable for automobiles and aircraft

“Advanced Composite Center (tentative name)” (planned)

“Resin Applications Development Center” (existing)

Sales of the automobile application business:
FY2006 actual: ¥124 billion
FY2015: aim to expand to ¥350 billion

¥20 billion of capital expenditures
Under the Project on Nano-structured Polymeric Materials of NEDO, Toray and Professor Inoue Group in Yamagata University co-developed a revolutionary nano-alloy plastic. Normally characterizing as high-performance plastics in terms of strength and rigidity, this impact-absorbing plastic changes its shape like rubbers under fast or powerful impact. As a pioneering material that rewrites the common wisdom on plastic performance, this nano-alloy will pave the way to expansion into totally new applications and fields.

### Structure

Nano-alloy (newly developed material)

Transmission electron microscope

```
200nm
```

20nm

### Features

Comparison using high-speed impact testing (JARI)

Existing material

- Break

Nano-alloy (newly developed material)

- Non-break (flexible)

### Applications

Pedestrian protection measure parts: balance competing properties of strength during normal use and impact-absorption upon collision

Electric and electronic components, parts of sporting goods: energy absorbency

L/D=100 twin-screw extrusion machine

[long retention time by high L/D]

L: screw length, D: screw diameter

co-developed product with Toshiba Machine Co., Ltd. (Yamagata University)
**Carbon Fiber (CF)**

Performance advances of carbon fiber and development of aircraft applications (e.g. Boeing Co.)

<table>
<thead>
<tr>
<th>Year to Launch</th>
<th>1982</th>
<th>1996</th>
<th>2008</th>
<th>20XX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>B767</td>
<td>B777</td>
<td>B787</td>
<td></td>
</tr>
<tr>
<td>Applied Structure Level</td>
<td>Secondary</td>
<td>Primary / Secondary</td>
<td>Primary / Secondary</td>
<td></td>
</tr>
<tr>
<td>Used CF type</td>
<td>T300H</td>
<td>T800H</td>
<td>T800S</td>
<td></td>
</tr>
<tr>
<td>Amount of CF / aircraft (tons)</td>
<td>1</td>
<td>approx. 7</td>
<td>approx. 30 (estimate)</td>
<td></td>
</tr>
</tbody>
</table>

Manufacturing process and fundamental technologies for the pursuit of ultimate properties

- PAN polymerization / yarn-making
- Oxidation
- Carbonization
- Surface treatment
- Carbon fiber

New materials (under development)

Tensile strength (GPa)

Tensile Modulus (GPa)

Next generation high-performance carbon fiber
R&D Strategy for Life Science Fields

Pharmaceuticals
- Dedication to Drug Research in Focused Therapeutic Areas
- Pursuit of Medicinal Chemistry & Biotechnologies

New drug discovery & development

Life cycle management
- Line extension

Life Science Information & Technology

Renal Disease Information

Synthetic Organic Chemistry
- Polymer Science
- Biotechnology
- Nanotechnology

Medical Products
- Integration of Polymer and Biotech.
- Extracorporeal circulation technology
- High-performance medical columns

Bio-tools
- Generation of Personalized Medicines
- Bio-chips
- Hollow fiber membranes-based devices

Information of Disease Markers
- Tools for Drug Discovery
- DDS / Formulation Technology

Life Science Information & Technology

Polymer Materials

Advanced Nanotechnology
Topics of Advanced Materials

Life Science

DNA-Chips

Labo-on-a-chips
# Development of New Drugs

## Antipruritic Drug (TRK-820)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Therapy for intractable pruritus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>(\kappa)-Opioid agonist</td>
</tr>
</tbody>
</table>

[Diagram: Blocking the transmittance of itching signal at two places]

- **Current status**: Pre-Registered
- **New drug application**: (Nov, 2006)
  - Toray Japan Tobacco / Torii Pharmaceutical

### Effect

- Inhibition of pruritus (5\(\mu\)g / body)
- No potential to induce dependency

### Before vs. After Dosage

**Control group**: TRK-820

- Weak pruritus → Strong
- Before dosage
- TRK-820 after 2 weeks

## PEGylated Interferon \(\beta\)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Extension of the effective plasma concentration of interferon (IFN) (\beta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Integration of biotechnology and synthetic organic chemistry</td>
</tr>
<tr>
<td></td>
<td>PEGylation to the optimum amino acid of IFN (\beta)</td>
</tr>
</tbody>
</table>

### Effect

- Fewer numbers of doses, high therapeutic effect
- Extension of the effective plasma concentration
- Wide-ranging indications (clinical study planned to start in 2008)

### IFN Type

<table>
<thead>
<tr>
<th>IFN type</th>
<th>Therapy-effect</th>
<th>Effect duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFN-(\alpha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEG-IFN-(\alpha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFN-(\beta)</td>
<td></td>
<td></td>
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<tr>
<td>Toray PEG-IFN-(\beta)*</td>
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* Prediction based on results of animal testing, etc.
## New Drug Research Policy

**New drug development**
- Global development
- Creation of blockbusters

**Life cycle management**
- Line extension
- Business expansion into surrounding and novel therapeutic areas

**New drug research**
- Creation of innovative drug candidates

### Focused Therapeutic Categories & Research themes / Characteristics

<table>
<thead>
<tr>
<th>Focused Therapeutic Categories</th>
<th>Technology</th>
<th>Research themes / Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MedChem</td>
<td>Biotec</td>
</tr>
<tr>
<td>Neurology (pain / pruritus / urinary frequency)</td>
<td>□</td>
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<tr>
<td>Renal Diseases Diabetes</td>
<td>□</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Immunology (autoimmune disorders / cancers)</td>
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<td>□</td>
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</table>
**Cancer Immunotherapeutic**

**Objectives**
- Develop cutting-edge medical fields / Create innovative drug for cancer treatment
- Identify cancer-specific novel cancer antigens
- Activate immune cells to affect cancer cells only

**Technology**
- Isolate / identify uniquely novel cancer antigens
- Cultivate human hepatocytes
- Infection rate (%)

**Current status**
- Effects confirmed through doctor-centered clinical trial (at overseas University)

**Graph**
- Therapeutic effect
- Colon cancer: animal model
- Size of tumor
- Days after tumor inoculation

**Graph**
- Size of tumor
- Days after tumor inoculation

**Table**

<table>
<thead>
<tr>
<th></th>
<th>effect</th>
<th>adverse effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>existing anti-cancer drug</td>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>cancer immunotherapeutic</td>
<td>large</td>
<td>extremely small</td>
</tr>
</tbody>
</table>

**Hepatitis C Vaccine**

**Objectives**
- Prevention and therapy for hepatitis C
- Collaboration with National Institute of Infectious Diseases / Tokyo Metropolitan Organization for Medical Research

**Technology**
- Infectious HCV particles
- Mass preparation was achieved (world’s first in 2005)
- HCV genome

**Graph**
- Infection rate (%)
- 85% inhibition

**Note**
- This research is supported by the Ministry of Health, Labour, and Welfare

This page contains information on cancer immunotherapeutic and hepatitis C vaccine technologies. The cancer immunotherapeutic technology aims to develop cutting-edge medical fields, identify cancer-specific novel cancer antigens, and activate immune cells to affect cancer cells only. The hepatitis C vaccine is focused on prevention and therapy for hepatitis C, with mass preparation achieved for infectious HCV particles. Both technologies have undergone animal testing and clinical trials, demonstrating significant therapeutic effects.
Strategies for Bio-tools Business

Toray Fundamental Technologies

<Polymer>
- Biocompatibility
- Material Design
- Advanced Materials

<Bio>
- Ligand Design
- Protein Engineering
- In vitro/vivo evaluation

<Nano>
- Self organization control
- Fine Patterning

<Pharmaceuticals>
- Drug screening
- Pharmacodynamics
- Drug safety
- Quality design

Innovative Bio-tools

- High-sensitivity DNA chip “3D-Gene”
- Lab-on-a-chip
- Hollow-fiber membranes-based devices

Collaboration with Academia

- Clinical information
  - Gene & protein markers
    - Kyoto Univ.
    - HS Foundation, etc.

Research application

- marketing by Toray
- analysis on consignment
- collaboration with external distributor:
  - DNA Chip Research Inc.

Business Collaboration

- For test drugs / Diagnostic agents
  - collaboration with diagnostic product companies
  - collaboration with clinical laboratories
  - sales of test drugs / diagnostic agents

- JMCA (Biochip Consortium)
  - Chair (Toshiba), Vice-chair (Toray)

★ Establish Toray characteristic technology platform
★ Develop product line that follows the trend of personalized medicines (with various contents)
Topics of Advanced Materials

Environment/Water-related/Energy

Polylactic Acid

Seawater Desalination System

Fuel Cell
**Environment / Water / Energy**

### PVDF Hollow Fiber Membrane Module

**Objective**

Full lineup of separation membranes for water treatment → membrane HFU for turbid surface water (downstream of estuaries, lakes, etc)

**Technology**

Form composite hollow fiber membrane with nano-structure control technology

- World smallest pore size (molecular weight cut off: 150,000) as a PVDF hollow fiber membrane for water treatment
- 10nm

- Low fouling separation layer
- High-strength, high-permeability Support layer

※operation possible with half the filtration pressure compared to conventional type (energy saving)

**Current status**

In operation at a drinking water production plant in Japan (5,300 m³/day, equivalent to water for daily use of about 25,000 people)

★Expand scale of water treatment business to 100 billion yen in 2015

### Polymer Electrolyte Membrane for Fuel Cells

**Objectives**

Develop innovative hydrocarbon-type electrolyte membrane with high durability

**Technology**

Nano-level material design based on new concepts

- Conventional electrolyte membrane → polymer chain is in an entangled structure
- Innovative electrolyte membrane → strengthened cross-interaction between polymer chains

**Power generation performance:** equal to fluorin-type electrolyte membrane

- Fluorine-type membrane
- Hydrocarbon-type (conventional)
- Hydrocarbon-type (Toray developed product)

**Relative strength**

- upgraded by nearly 4 times

- Hydrogen permeability

*operation possible with half the filtration pressure compared to conventional type (energy saving)

**Current status**

Under evaluation by electronics companies for DMFC use → scheduled completion of technology (FY2007) → sequential development of automobile applications

※ this research is part of the project of NEDO (New Energy and Industrial Technology Development Organization)
Target for Advanced Materials Growth

★ Triple net sales of advanced materials in ten years.
★ Increase advanced materials ratio of net sales from the current 30% to 60%.
Research & Development Strategy

Recruiting & Developing of Human Resources
Personnel Acquisition and Training/Revitalization

- Personnel must be acquired and trained to strengthen development capabilities
- Increase hiring of capable experienced staff in development units of new business areas

Personnel acquisition

- Early commercialization of Advanced Materials field
- Creation of new products/technologies
- Increased hiring of experienced staff in new fields
- Continuation of periodic hiring of new university graduates
- Building of information/human networks in academia/industry
- Strengthen individual recruiting and university rounds

Personnel training

- High expertise
- Ample creativity
- High energy
- Selection and training of next leader candidates
- Active use of young talented researchers
- Active utilization of women
- Improvement/revitalization of Fundamental Technologies Conference
- Merit-based Objective management/assessment
- Objective/transparent assessment
- Rotation between research, development, and production
- Leadership training
- Manager training
(1) Research/Technology Specialist System
- Duty, qualification, and position system
- Promotion review for research specialists

(2) Research Fellow System
- Clear indication of researchers who are exemplary specialists
- Establishment of a climate devoted to research
- Establishment of a climate where young researchers work hard to become specialists

(3) Director for specialty field, Senior Director/Senior Director for specialty field System
- Advanced specialists in their field
  (Equal to divisional director or equivalent effects/contributions expected)

Currently certified research fellows*

<table>
<thead>
<tr>
<th>Year Author-ized</th>
<th>Specialty</th>
<th>Lab Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Genome drug development</td>
<td>Pharmaceutical Research Laboratories</td>
</tr>
<tr>
<td>2003</td>
<td>Medicinal chemistry</td>
<td>Pharmaceutical Research Laboratories</td>
</tr>
<tr>
<td>2004</td>
<td>Polymeric structural design</td>
<td>Films &amp; Films Products Research Laboratories</td>
</tr>
<tr>
<td>2004</td>
<td>Polymeric materials design</td>
<td>New Frontiers Research Laboratories</td>
</tr>
<tr>
<td>2004</td>
<td>Electronic materials properties</td>
<td>Electronic &amp; Imaging Materials Research Laboratories</td>
</tr>
<tr>
<td>2005</td>
<td>Advanced Composite Materials design</td>
<td>Composite Materials Research Laboratories</td>
</tr>
</tbody>
</table>

* Certified by annual review

Management climate that encourages employees to strive to become advanced specialists
“IT-2010/R&D Innovation”

Four major growing business fields
- Information/Telecommunications/Electronics
- Automobiles/Aircrafts
- Life Science
- Environment/Water-related/Energy

R&D provide the key to building the Toray of tomorrow.”

Strategic Focusing of Themes
- APEX40-

Advanced Materials

Creation of Next Large-scaled Themes

Challenge for Innovative R&D

Creation of Original 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.