



Innovative Research and Development



Innovative research and development is Far Eastern New Century's key strength. Other than actively improving research, development, and design abilities, as well as higher values for products, we also combine the manpower and resources of Yuan Ze University, Oriental Institute of Technology and Far Eastern Memorial Hospital expanding core technological abilities, developing high-profit emerging products and high value-added products which meet market demand, and strengthening our competitive advantage in the market.





Far Eastern New Century Research and Development Strategies

Strategy 1

Integrating internal research and development resources. Speeding up the development of new core-technology high value-added products. Strengthening our industrial competitive advantage.

Strategy 2

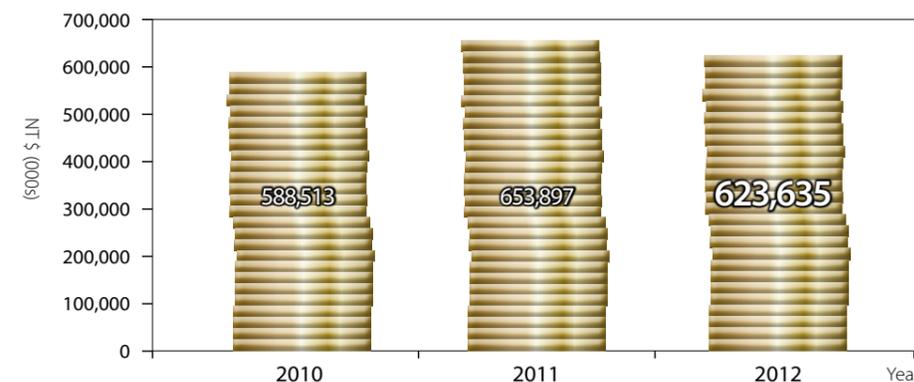
Strengthening domestic and international sharing. Integrating the skills of biological medicine, photoelectricity and green energy. Developing into diverse areas and creating new industrial values.

Strategy 3

Nurturing talent. Strengthening energy of research and development. Taking steps towards excellent corporate.

We continue to put effort into our research and development. The research and development budget for the past three years consists of over 1% of operational revenue. We continue to inject new energy into industrial innovation and stabilize the corporation's competitive advantages.

Far Eastern New Century Research and Development Budget



Solid Research and Development Team

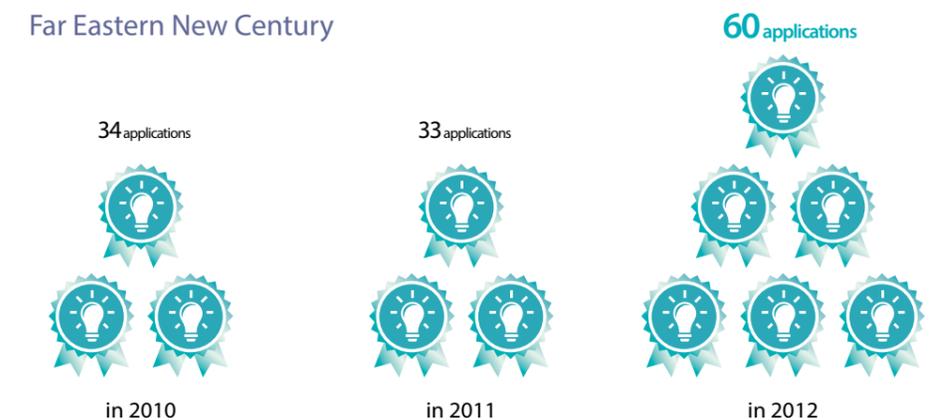
In 2001, we established the "Far Eastern Group R&D Center." In the short term our goal is to "focus on polyester, environmental protection, energy saving and carbon emission reducing", and we use as our basis accumulated polyester compound technology. With polyester as a foundation we have expanded and developed compound raw materials and products, and we promote the application of polyester in high value-added industries.

With regards to long-term planning, we are focused on green energy and the biomass industry, and we are actively developing polyester raw materials with biomass raw materials. In order to maintain our advantages in innovative research and development, we have established a research and development center in Shanghai, and we are currently actively planning the establishment of a center in Yangzhou, which will allow us to continue accumulating skills and competitive abilities.



The "Far Eastern Group R&D Center" is divided into the Polyester Fiber & Textile Div., Polymer Div., Green Materials Div., Optoelectronics Div., and BioTech Div.. The research and development team members are in possession of high educational levels and research and development abilities, with 55% having Masters Degrees and 10% PhD Degrees. Striking achievements have been made in the research and development of new products and in skill development, and applications for patent protection of research achievements have been made in many countries; since the end of 2012 we have applied for 270 patents. In order to strengthen our research and development, in 2012 we invested approximately NT\$300 million in our research and development budget.

2010-2012 Patent Applications in Far Eastern New Century



Areas of Research and Development

Division	Category	Feature
 <p>Polyester Fiber & Textile</p>	PET Materials	Developing PET modified materials which are novel, high value-added and environmental-friendly green products.
	Elastomer Materials	Developing new products such as breathable & waterproof TPU/TPEE films, TPEE composite monofilament and PUR hot melt adhesive.
	Non-PET Fabric Materials	Developing non-PET fiber materials which are novel, high value-added and environmental-friendly green products.
	Functional Fabrics	Developing new functional fiber and fabric products
	PET recycling	Improvement of recycling techniques and processes
 <p>Polymer</p>	Coating	Coating, ink, adhesives & sealant for optical electronic products. Functional coating & ink for specific purpose.
	Green & Recycled Polymer	Biodegradable Polymer Application of Bio-based Material (Starch) blending technology. Recycled PET
 <p>Biotech</p>	Wound care dressings	We have developed a series of wound dressings which can be used in inflammatory phase until scar reconstruction phase
	Functional medical materials	We are focusing on dental materials, silicone hydrogel and elastic fabric development
	Orthopedic materials	We have developed orthopedic materials, such as absorbable bone nails, screws, plate and bone graft substitute
	Antimicrobial polymer	The mechanism of our antimicrobial polymer is "contact killing way" and no poison will be released.
 <p>Optoelectronics</p>	Optical compensation film	We developed functional optical compensation films that correspond to all kinds of liquid crystal display panels, especially for film type pattern retarders used in 3D display
	Surface functional film	Functional layer on substrate. Wet coating.
	Transparent conductive film	We can provide large area and uniform transparent conductive film by roll to roll coating process.
	PEDOT coating formulations (Conductive polymer)	Wet coating Transparent Low-dependence on humidity
 <p>Green Materials</p>	Cellulosic ethanol production	A pretreatment step is required in order to open the structure of the cellulosic ethano in order to improve the efficiency of the following enzymatic hydrolysis, our primary feedstock of interest is agricultural residues.

In order for us to understand and develop green technology, we must simultaneously consider energy safety, food safety, and sustainable development. We have to invest in a large amount of research and development resources, and select the cellulose in agricultural waste to create cellulosic ethanol (second generation bio-ethanol), at the same time as ensuring sustainable corporate development this avoids food shortages and rising food prices.

In 2012 the Far Eastern Group R&D Center applied for the "Process Development for Lignocellulosic Ethanol Technology." The total budget of the plan is NT\$42.54 million, with the government providing a subsidy of NT\$15 million (35% of the budget). We predict that this will promote the development of domestic industries and benefit the environment. The predicted benefits of this plan include:

- 1. Economic use for fallow cropland:** There are approximately 240,000 hectares of fallow cropland in Taiwan, and government subsidies for fallow cropland reach NT\$11.8 billion. If we can use fallow cropland to grow energy crops and produce bio-ethanol, this could be beneficial for reducing greenhouse gas emissions and help solve energy shortage problems. At the same this would allow us to improve land use ratios and the income of farmers.
- 2. Reduction of carbon emission:** The total life cycle of cellulosic ethanol production (including plant growth, collection, ethanol procedures, and use) not only produces no CO₂, but can also cut the amount of CO₂ in the environment by 0.13 tons. Using cellulosic ethanol production to replace a tank of gasoline can cut CO₂ emission by 0.55 tons.
- 3. Upgrading international competition in Taiwan:** Cellulosic ethanol production is a goal of all countries, and Far Eastern New Century predicts that after our plan is complete we can become the first corporation using cellulose to produce ethanol, boosting Taiwan's international competitiveness.
- 4. Promotion of the development of Taiwan's green chemicals industry:** If the production technology for cellulosic ethanol can be successfully completed it can promote the green ethylene glycol industry and create a green polyester industry in Taiwan.

What is "Cellulosic Ethanol?"

Currently, the production of ethanol involves raw material grain crops such as corn, sorghum, sugar cane, and wheat. It is generally called first generation bio-ethanol or starch ethanol. Due to recent population increases and global warming, global grain prices are rising, pushing up the production costs of bio-ethanol and creating the problem of having to compete with ordinary people for grains.

In order to solve this urgent demand for raw materials, in recent years developed industrial nations have started using as the raw materials for bio-ethanol agricultural waste such as rice straw, wheat straw, corn rachis and sugar cane residues. This is known as "cellulosic ethanol." As traditional agricultural waste is usually burned or buried, if we can successfully convert its wooden cellulose into ethanol, we not only can solve the long-term energy crisis faced by humanity, but also bring about the twin benefits of environmental protection and revitalization of the agricultural economy.

The production of cellulosic ethanol through bio-MEG can not only lower our dependence on petroleum, but in addition, according to the current specifications of the Kyoto Agreement, plant raw materials cannot be included in carbon emission figures. This is because the Bio-PET produced by bio-MEG emits 30% less CO₂ than PET which has petroleum as its raw material, and is thus beneficial to global ecology.

Green Products

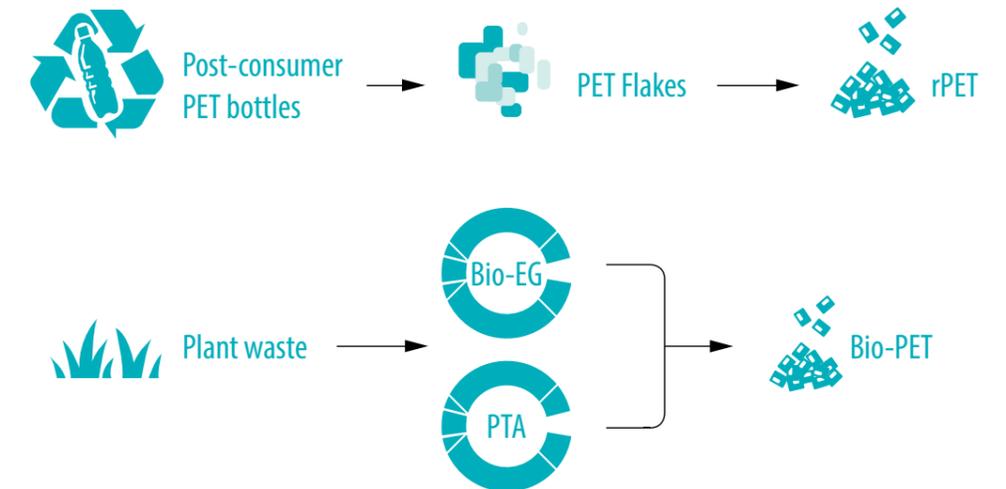
Promise of green product research and development

We continue to invest resources into the research and development of sustainable green products.

Green products research and development goals

Replacement of petroleum raw materials: We have completely realized the ideals of biomass raw materials and recycling.

Non-pollution: After products are abandoned they can be recycled or decompose naturally, creating no waste pollution.



PET (polyethylene terephthalate) is currently one of the most widely used plastic raw materials. The PET industry has its origins in the petrochemical industry, and in the future it will also face the same problems as other plastic industries, such as rising oil prices, raw material shortages, and carbon dioxide emissions. How to establish sustainable development for the PET industry has already become an important topic faced by the whole PET industry.

By responding to the international trends in the industry towards low carbon emissions and environmental protection, our goal is to move towards green industry and establish a green energy research and development team. We promote green product research and development, and actively develop green products such as Bio-PET, Recycled-PET, and biodegradable materials.

Through strategies and techniques such as waste recycling and reuse and the development of biodegradable materials, we actively commercialize green environmental protection products. Because of this, in 2011 we won the "Taiwan Green Classics Awards" from the Ministry of Economic Affairs. The products that were awarded prizes include Biodegradable Polyester FEPOL®, the food-grade recycled PET chips Pro-Green, and the polyester recycled fiber Topgreen.

Our rPET Alloy has also passed the SGS product carbon footprint PAS 2050: 2008 certification. rPET Alloy is made of recycled PET, and can be used in engineering plastics. We predict that in the future it will be able to replace cell phone shells, notebook shells, and other plastic parts of electronic devices. We are currently working with many large electronic factories, allowing us to write a new chapter in the application of Recycled PET. This is a new milestone for green product development.

In addition to this, we also actively work with international beverage and sports brands to promote energy saving and environmental protection products in order to lower the use of energy and resources. This includes food-grade plastic sheet and PET bottles made of bio-PET chips and recycled PET chips, or functional textile products made from recycled fiber and biomass.





Green Environmentally-Friendly Food-Grade PET Chips

(Recycled PET)

The Pro-Green produced by Far Eastern New Century can replace the PET chips made from petroleum on the market (the raw materials of PET bottles). Using recycled PET bottles as raw materials reduces their environmental impact and fulfills the "bottle-to-bottle" concept of environmental protection.

If recycled PET raw materials are used in food-grade packaging materials, a higher level of cleaning is required. Pro-Green produced by Far Eastern New Century has passed the US FDA food-grade quality approvals and the SGS Leachable Testing for Food Container. It is proven that there are no safety concerns when it is applied to food packaging. In addition, Pro-Green uses recycled PET bottles as raw materials, and emits 50% less carbon than other PET chips. It fulfills the three Rs of green values – reduce, recycle, reuse.



Food-grade quality approvals	<ul style="list-style-type: none"> • US FDA food-grade quality approvals in 2010 • Passed SGS Leachable Testing for Food Container in 2010
Quality approvals from international beverage brands	Coca-Cola, Pepsi, Danone, Nestle
Quality approvals from prestigious cosmetic brands	Body Shop, L' Oreal
Approvals from global injection molding companies	IKEA, Sabic
Taiwan Green Classics Awards	FENC received "Taiwan Green Classics Awards" in October, 2011.

Polyester Recycled Fiber

Polyester recycled fiber uses recycled PET bottles as its raw material after the multiple processes of sorting, cleaning, crushing, de-polymerization, re-polymerization, melting, spinning to recycled fiber. In order to lower polyester fiber's dependency on petroleum, it can act as a replacement for the polyester fiber made of petroleum currently on the market.

PET bottles and polyester fiber are made of the same raw materials. The burning or burying of PET bottles can incur high processing and social costs, as well as polluting the environment. Through recycling processes and recycling technology on abandoned PET bottles, we can create bottle flakes that can further processed to become chips. In order for the standards and requirement of cleanness of recycled PET bottles to reach fiber grade, they can be made into recycled polyester fiber through textile and spinning processing. Abandoned plastic, which originally caused environmental problems, can become recycled and reused resources, and lower the demand for petroleum.



Green Mark	Received the green mark of "recycled textile products and other products" from the Environmental Protection Administration.
Certification of hazardous substances in textile	Received the certification of hazardous substances in textile products (Oeko-Tex Standard 100) in 2011.
Certification of Global Recycle Standard (GRS)	<ul style="list-style-type: none"> • Received the Global Recycling Standard certification in 2011. • Received the SCS 100% Recycled Content certification in 2011.
Taiwan Green Classics Awards	Received the 1st "Taiwan Green Classics Award" in October 2011

Biodegradable Polyester



Plastics are traditionally made from light and cheap material whose characteristics include high mechanical strength, heat resistance, and acid and alkali corrosion resistance. Products from shopping bags and containers to all kinds of household electronics use plastics. According to statistics, over 200 million tons of plastic products are produced annually. Materials include PVC, PE, PP, and PS. However, these plastic materials are not only difficult to decompose, but after use can only be burned, which produces severe pollution problems.

Far Eastern New Century's FEPOL® is a new form of polyester environmentally-friendly material which decomposes easily. It can be seen as a biodegradable plastic (also known as green plastic). It is a plastic material that can decompose in the natural world. After use it is processed with manure, which only produces CO₂ and H₂O. It does not burden and impact upon the environment, and after manure processing the organic and natural materials can increase the added value of raw materials, greatly reducing plastic pollution problems.

With the trends of environmental protection and sustainable development, FEPOL® biodegradable polyester can hopefully replace most traditional plastics, lowering their environmental impact and benefiting the world's natural and ecological environment.



BPI approval	US Biodegradable Products Institute Certification in 2010
OWS approval	<ul style="list-style-type: none"> • Quality approval from OWS (Organic Waste Systems) in Europe, 2009. • We have met the standards of EN 13432 (2000), ISO 17088 (2008), and ASTM D6400 (2004). We have also passed the heavy metal testing, compost is not hazardous to the environment.
Taiwan Green Classics Awards	Received "Taiwan Green Classics Awards" in October 2011.
Patent Results	Obtained invention patents from Taiwan, China, and the United States.

Polyester Shrinkage Film



The labelling materials of PET bottles were originally made from PVC. However, the burning of PVC produces dioxin, which can have great impact on the environment and on people's health. Based on the need for environmental protection, Far Eastern New Century has developed the polyester shrinkage film as a replacement for traditional PVC materials.

The polyester shrinkage film is developed by core technology, which has positive mechanical, optical, and printing functions. Not only can it be used to make labels for PET bottles, but it can also be recycled with the bottles themselves. This eliminates the procedure of separating the label from the bottle. It saves recycling costs, and also reduces pollution, playing a positive role in helping protect the environment.



August 2010	European Invention Patent
September 2010	ROC Invention Patent
May 2011	China Invention Patent
September 2012	Taiwan Chemical Industry Elite and Product Innovation Award from TCIA



Education and Training of Research and Development Talent



In order to have the chance to keep the Far Eastern Group R&D Center up to date with international trends, we have hired famous lecturers from around the world to conduct training and discuss patent, medical devices, and nanotechnology. In 2012 we conducted a total of 8 training sessions, which were attended by a total of 266 people. The training topics included:

Training Topics

1. The sterilization effects of medical devices and biological safety (sterilization effects of gamma ray and EO gas).
2. Basic Patent Training Courses
3. Intermediate Patent Training Courses
4. Hyaluronic acid crosslinking, PMMA bone cement
5. Using a mixture of hydraulic biological high polymers' microstructures and changing relationships to discuss the design of joint injection fluids
6. Electricity conductive adhesive glue
7. Collection and structure reports of corporate competition
8. Skills sharing in the nano-carbon material CNT area of research

Categorization of Courses

- | | |
|---------------------------|-----------------------------|
| 1. Professional knowledge | 4. Communication techniques |
| 2. Industrial knowledge | 5. Creativity |
| 3. Managerial knowledge | 6. Personal finance |

The total staff training hours at Far Eastern Group R&D Center was **2,775** hours.

Directions of Future Research and Development

With the impetus of the global trends of environmental protection, we predict that the application of traditional petrochemical products will be limited. In light of this, Far Eastern New Century is actively organizing the research and development of new materials. We hope to develop more environmentally- friendly materials, and make the best contributions to the industry and to the global environment.

