< 신섬유 개발현황 및 발전방향 >

2009. 11. 10

㈜효성 기술원
한광석 상무

Contents

효성그룹

효성기술원

연구분야

효성그룹

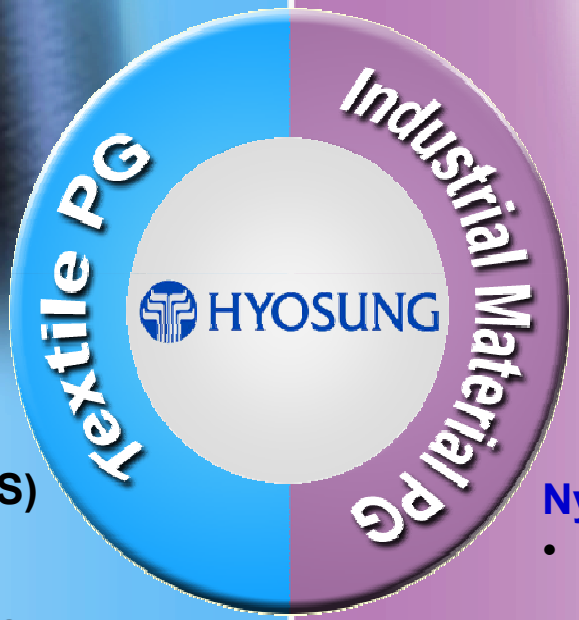
사업분야

7개의 PG, 24개의 PU

섬유	산업자재	화학	중공업	무역	정보통신	건설
스판덱스	타이어코드	TPA	전력	철강 I	노틸러스효성	건설
폴리에스터	Technical Yarn	PP/DH	기전	철강 II	효성인포메이션 시스템	효성에바라 엔지니어링
나이론	인테리어	패키징	효성에바라	화학	효성캐피탈	
염색&직물		필름		트랜스월드		
		Neochem				

★PG : Performance Group
★PU : Performance Unit

섬유 사업



Spandex
- Global No.2 (27% M/S)
- Domestic No.1 (75% M/S)

Nylon
- Domestic No.1 (49% M/S)

PET
- Domestic No.2 (16% M/S)

PET Tire Cord
- Global No.1 (40% M/S)

Nylon6, 66 Tire Cord
- Domestic No.1 (50% M/S)

Lyocell Tire Cord
- Hyosung developed the world's 1st lyocell tire cord.

★PG : Performance Group

HYOSUNG

효성기술원

생산기술연구소

상용화연구소

분석센터

생산기술연구소

HYOSUNG

스판덱스

특화된 기능으로 Global Market을 선도

- 전세계 Top Class 수준의 품질과 생산규모
- 다양한 기능의 차별화 제품 보유

creora®
WORLD SPANDEX

타이어코드

글로벌 베스트의 명성 유지

- 폴리에스터 타이어코드 세계 1위 업체
- 전세계 30%의 Market share 차지

Technical Yarn

고기능 산업용 섬유의 다양화

- 2008년 5월 장영실상 수상
  - 초고강력 PET 원사
- 2007년 세계일류상품 선정
  - 안전벨트용 PET 원사

상용화연구소

HYOSUNG

'핵심신기술 연구와 개발 수행'

상용화연구소

분석센터

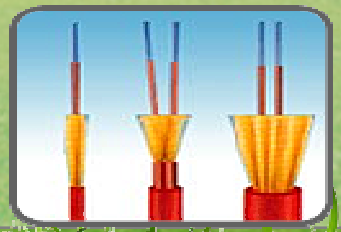
생산기술연구소

상용화연구소

HYOSUNG

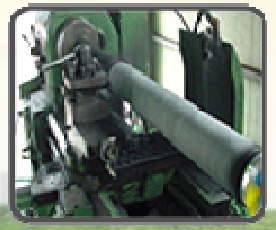
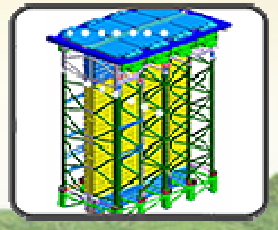
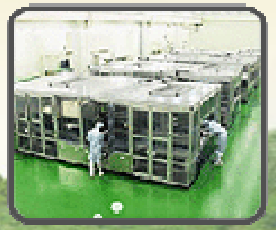
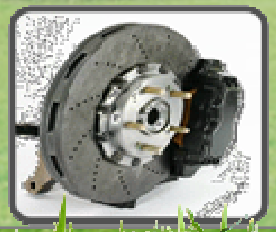
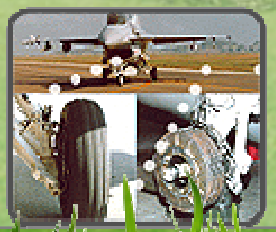
파라아라미드 슈퍼섬유

- 강철의 **약 5배의 인장 강도**
  마찰이나 열에 강함
  (산업용도로 사용됨)
- 용도 : 방탄·방호, 광케이블,
  복합재료 및 마찰재 등



탄소 복합소재

- 질량 함유율이 **92% 이상**으로
  이루어진 섬유장의 탄소재료
- 장섬유 (Long Fiber), 단섬유 (Short Fiber),
  직물 (Fabrics) 형태로 공급

상용화연구소

HYOSUNG

태양광전지

- 빛 에너지를 전기에너지로 변환
- 2010년 **$361억 시장예상**
  (1GW는 원자력발전 1기의 전력)

Polyketone 소재

- 고강도, 고탄성율, 우수한 내화학성의 새로운 산업용 소재

Engineering Plastics :
Super ENPLA 소재 (Automotive, Electrical, Coating, Packaging)

Super 섬유 :
Tire cord, 그 외 보강용/산업용 섬유

상용화연구소
분석센터
생산기술연구소

연구분야

HYOSUNG

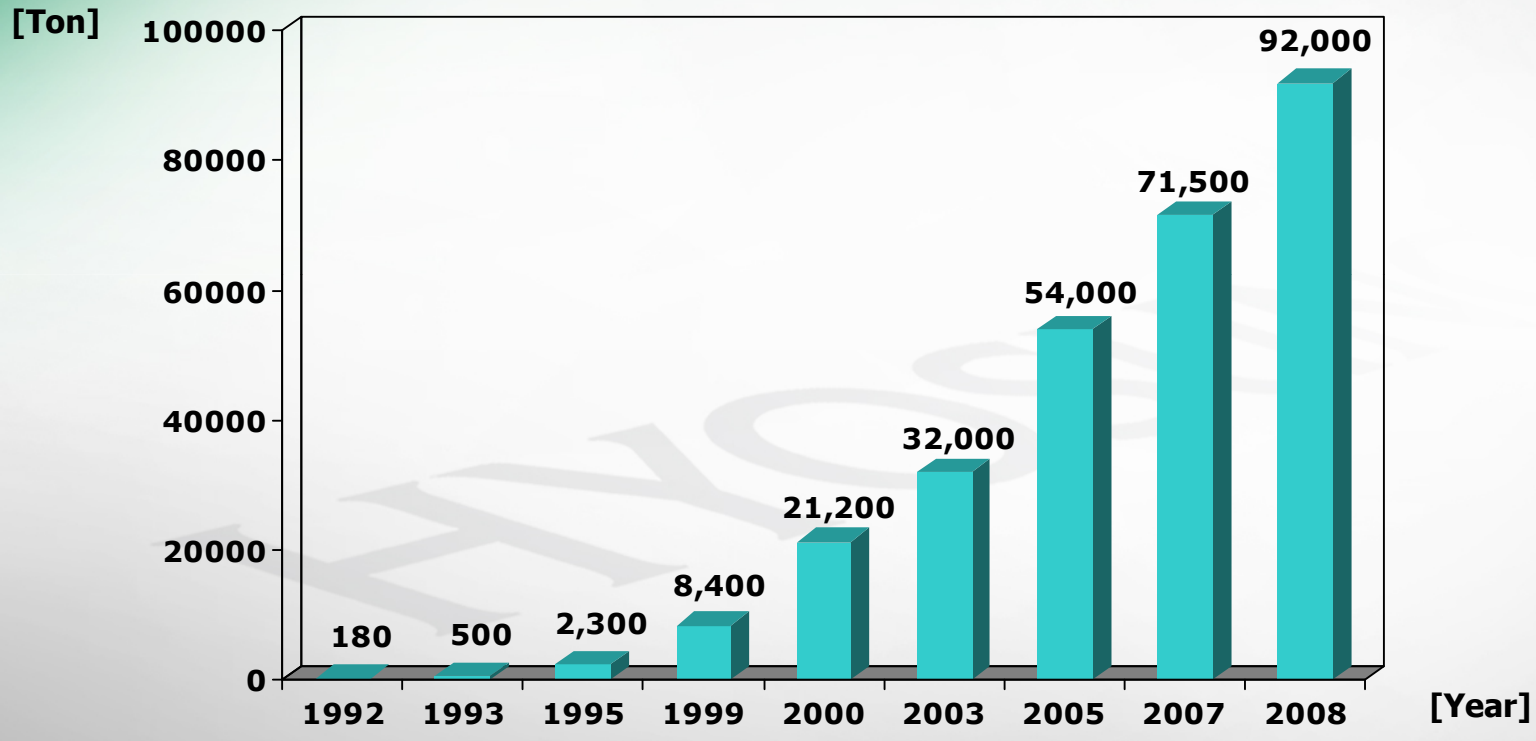
TEXTILE

SPANDEX **POLYESTER** **NYLON**

SPANDEX 섬유 creora

HYOSUNG

Production Capacity



► **Second largest & fastest growing global leading spandex producer**

- **Fully localized sales & marketing to service customer needs**
- **Dedicated to innovation and highest quality**

SPANDEX 섬유

creora

HYOSUNG

Global Operations

SPANDEX 섬유 creora®

HYOSUNG

Types / Properties

	TYPE		PROPERTY
REGULAR creora®	C 100	FEEL THE POWER	· Soft Power · Regular Product
	H 100	FEEL THE POWER	· High Power · Regular Product
	H 250	DIVE IN	· High Power · Chlorine Resistance creora®
SPECIALTY creora®	H 350	FEEL THE HEAT	· Heat Resistance · Chlorine Resistance creora®
	C 400/H 550	THE BEST OF BOTH	· Low Heat Settable creora®
	H 100D	ABSOLUTE BLACK	· Black Dope dyed creora®

SPANDEX 섬유

creora

HYOSUNG

Development

Brand's Needs (Garment)	Fabric	creora®
▪ 부드러운 Cottony 느낌의 T-shirts, Bra, Panty	부드러운 촉감이 유지된 원단 (저온 가공)	판매 中 Easy Set (H550)
▪ 가벼우면서 기능성(파워)은 유지된 Fitness, Cycling복	경량 高 Power 원단	개발 中 기존 원사 대비 Power를 30% 올려주는 원사
▪ 내구성이 보강된 실내 경기용 수영복	고 내염소성 원단	개발 中 高 내염소성
▪ 봉제선이 감춰지는 No Line Panty	재단 후 올 풀림이 방지되는 원단	개발 中 Antiladder

SPANDEX 섬유 creora

HYOSUNG

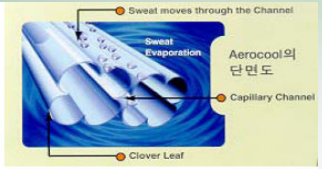
Vision: Global leader

POLYESTER / NYLON

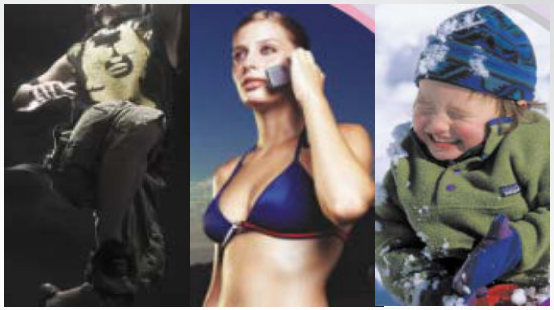
HYOSUNG

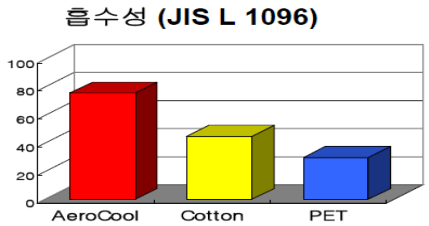
흡한속건 기능성 Polyester (aerocool)

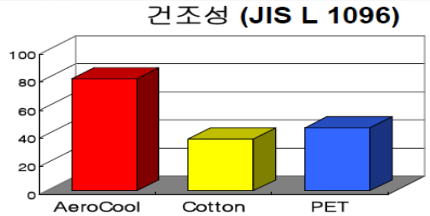
- 땀을 잘 흡수하고 건조하는 특징
- 반복세탁후 영구적 흡한속건성
  ⇒ Comfortable & Cool



▶ 용도 : 스포츠웨어, 수영복, 플리스





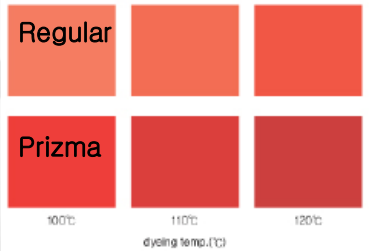


흡한속건성 + 발색성 (aerocool prizma)

- 우수한 염색견뢰도

Color Fastness	Prizma	Nylon
Color Fastness to Washing	4~5	4~5
Color Fastness to Sunlight	4	3~4
Color Fastness to Sea Water	4	1~2
Color Fastness to Chlorine	4	1~2

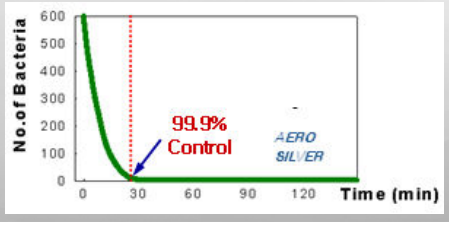
- 깊고 생생한 색상



[세탁후]

흡한속건성 + 항균성 (aerosilver)

- 항균성 : MRSA, Klebsiella pneumoniae, Escherichia coli



POLYESTER / NYLON

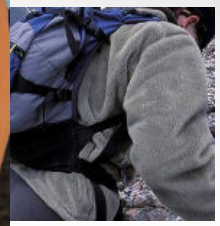
HYOSUNG

보온/냉감 Fiber

보온성 Fiber (aerowarm)

▶ 용도 : Outdoor, 스포츠웨어 등

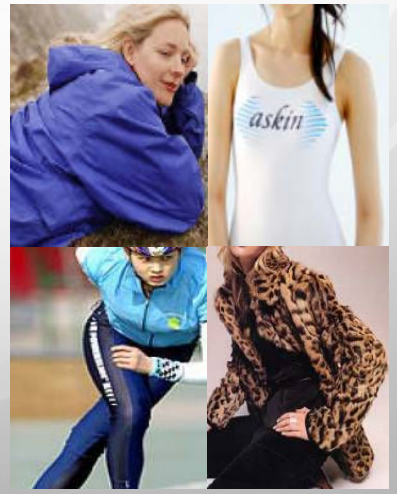
- Fall/Winter Season 소재
- Superior Warmth(보온성)
- Light Weight With Hollow-core(경량성)
  (by 35% Light weight)
- Moisture Absorbing(흡한속건성)
- Excellent Raising properties(우수한 기모성)
- Excellent Pilling resistance(항필링성)



접촉냉감 Fiber (askin)

▶ 용도 : 방풍자켓, 수영복, 스포츠웨어 등

- Askin의 독특한 단면 특성으로 인해 접촉 면적이 커서
  Reg.원사 대비 피부의 열을 잘 흡수함.
- UV Cut(자외선 차단성)
- Cooling Effect(접촉냉감)
- Wet touch(촉촉한 touch)
- Elegant Luster(고급스러운 광택)



POLYESTER / NYLON

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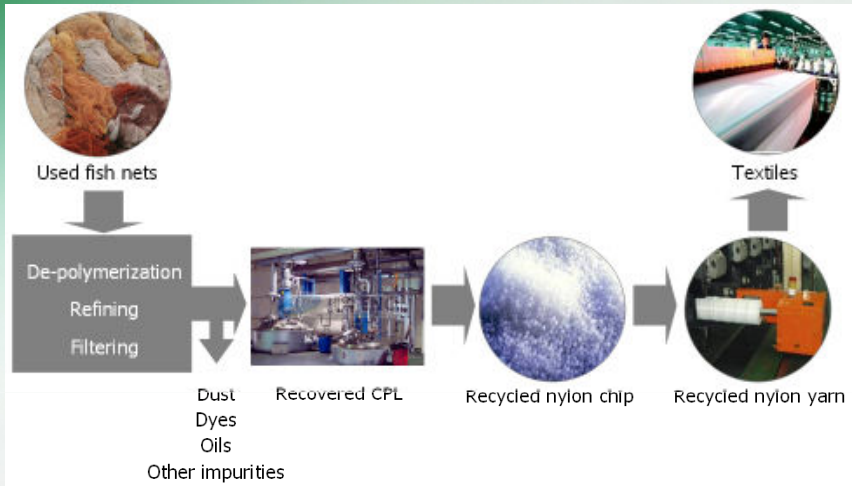
Recycled Fiber (Regen®)

Recycled Nylon

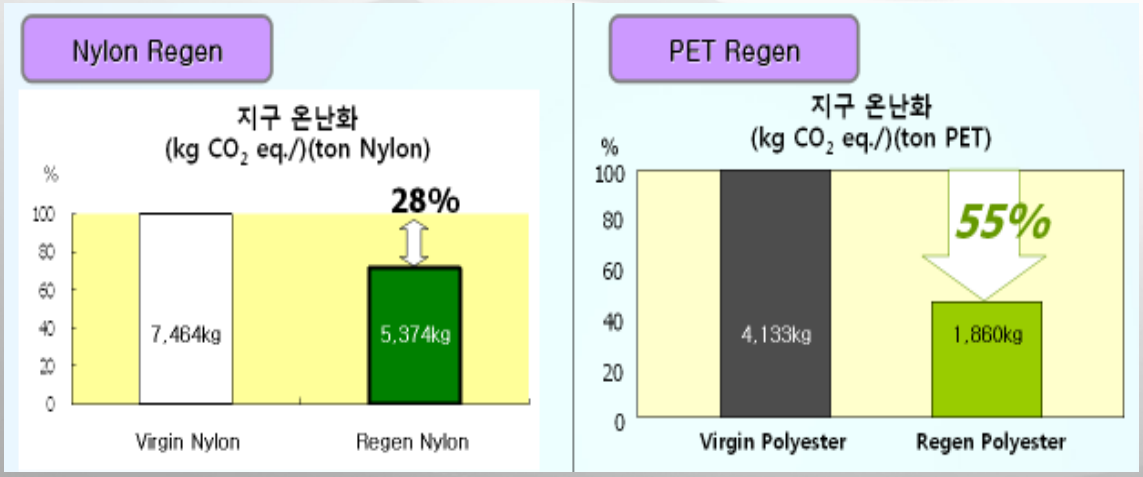
: 폐어망 → 카프로락탐 재생 → 장섬유



Recycled Polyester

: 폐 PET Bottle→PET Polymer재생→PET장섬유

환경영향(CO_2 배출)



▶용도

: 국내 및 세계 1군 브랜드 하우스와의 Joint Marketing

연구분야

HYOSUNG

INDUSTRIAL MATERIALS

TIRE CORD

TECHNICAL YARN

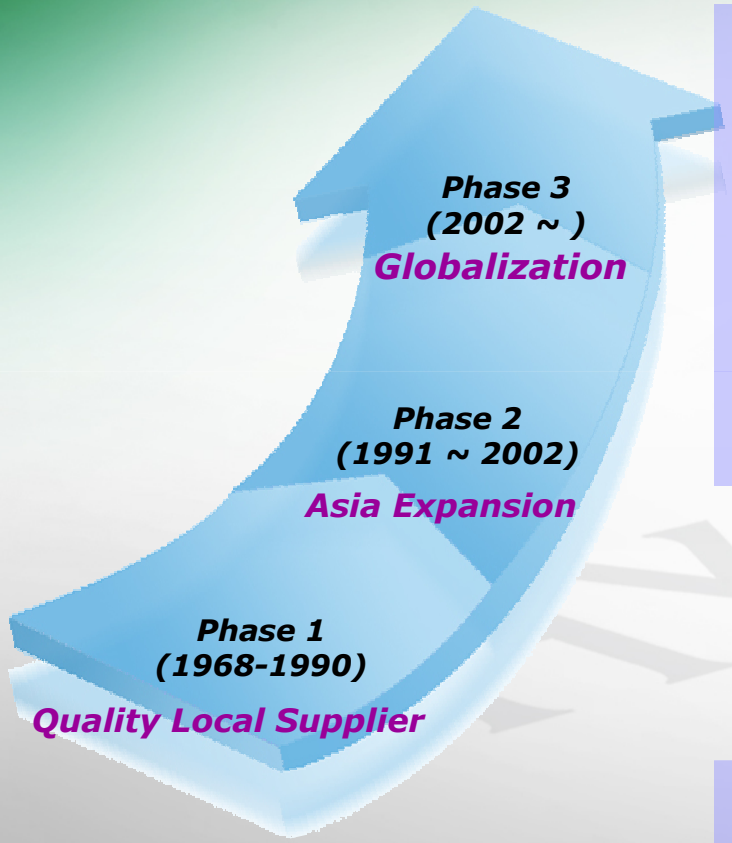
ARAMID FIBER

CARBON FIBER

TIRE CORD

HYOSUNG

Hyosung's Tire Reinforcements History



- 2008. Started production of PET in Vietnam
- 2006. Started production of Lyocell tire cord
- 2006. Acquired converting plants in USA, Luxembourg, and Brazil
- 2005. Acquired steel cord plant in Scottsburg, U.S.A
- 2004. Started production of PET and steel cord in China
- 2002. Acquired converting plant in Scottsville, U.S.A

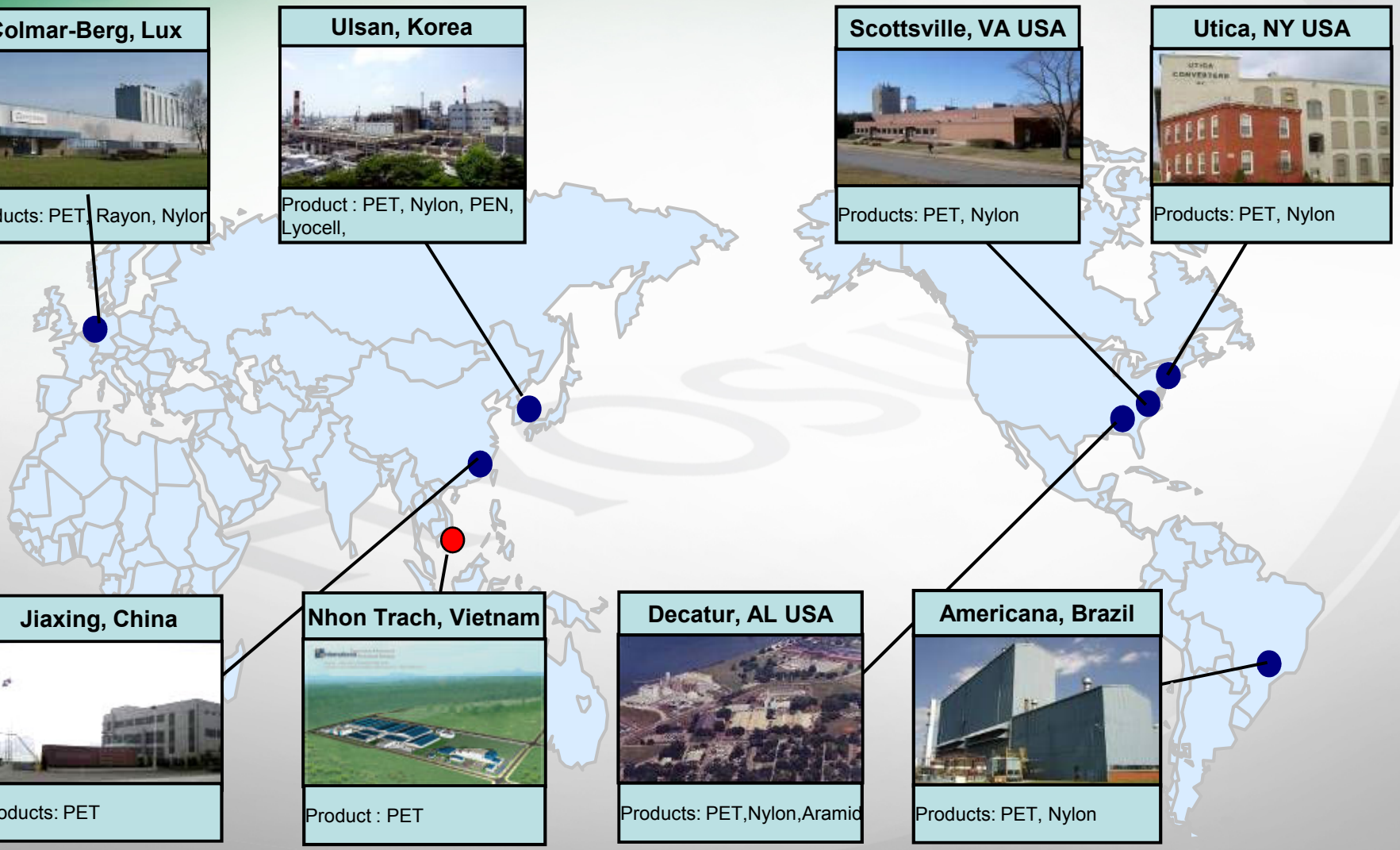
- 92~02 Continuous expansion of Korean facilities
- 1992. Began production of Nylon 66 tire cord
- 1991. Began production of Polyester HMLS type tire cord

- 1987. Began production of Steel cord
- 1979. Began production of Polyester tire cord & bead wire
- 1968. Began production of Nylon tire cord, first in Korea

TIRE CORD

HYOSUNG

Global Operations



TIRE CORD

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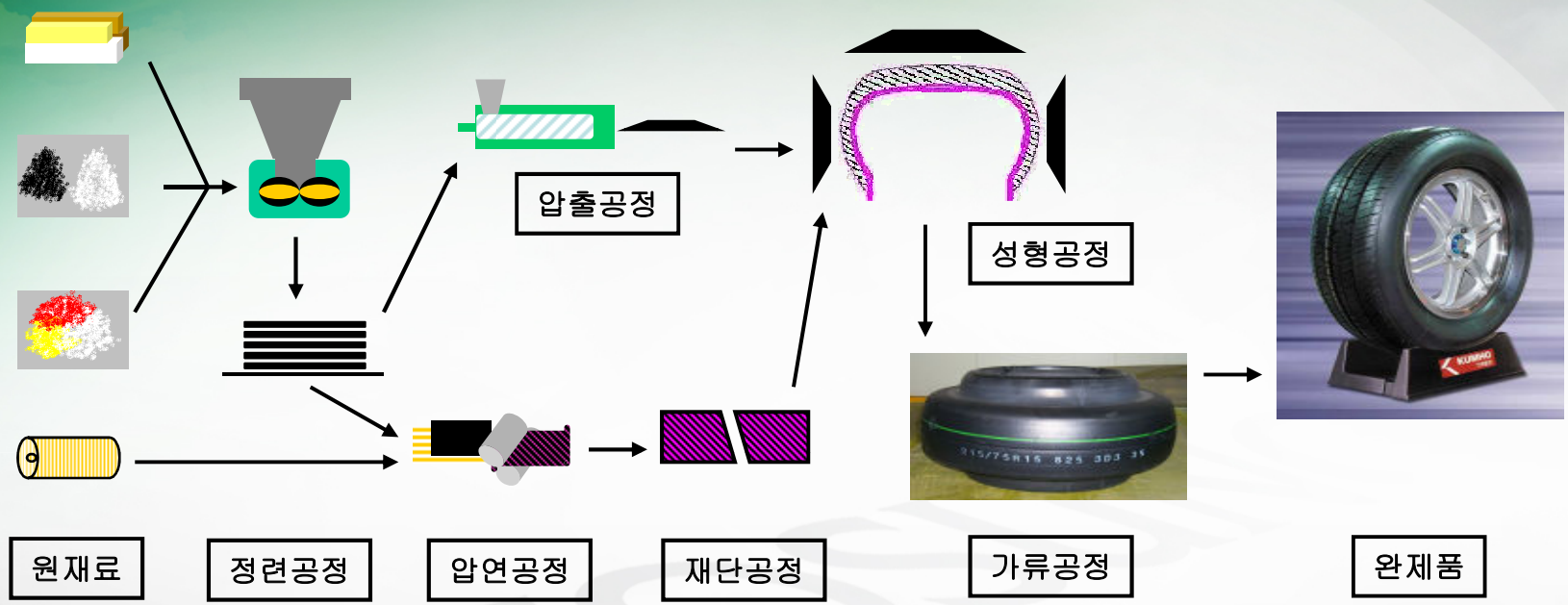
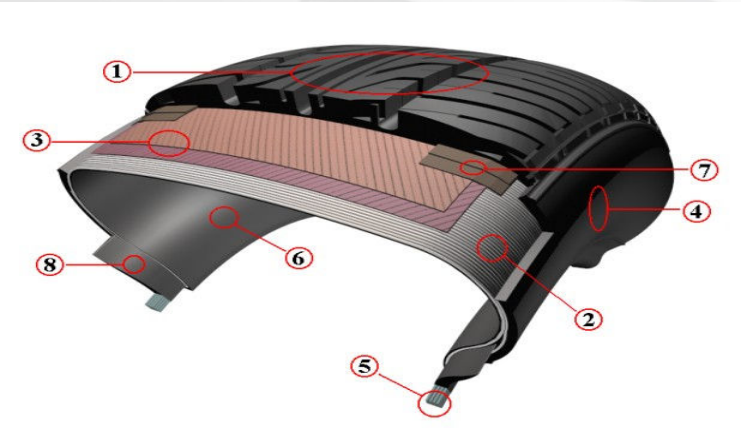
Manufacturing



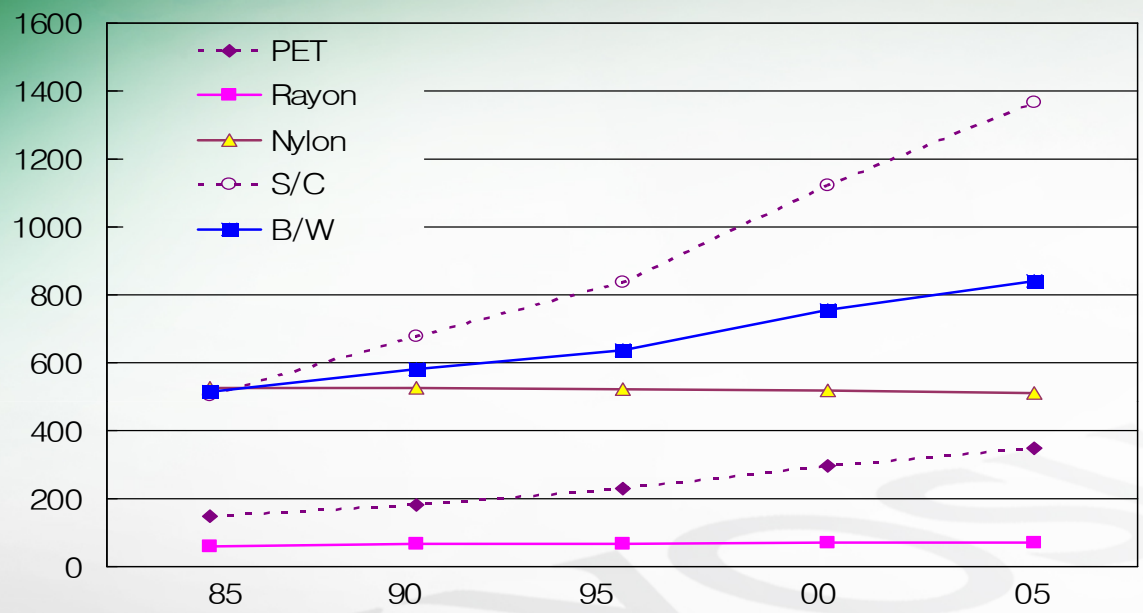


1. Tread
2. Carcass (PET,Rayon,Lyocell)
3. Belt (Steel)
4. Sidewall
5. Bead
6. Innerliner
7. Capply (Nylon,Aramid,PEN)
8. Apex

TIRE CORD

HYOSUNG

Tire Cords Market Trend



***Change in Tire Cords Market (Europe and USA)**

PA6 → phasing out

PA66 → trend from commodity to speciality (capply)

PET → more and more commodity, no premium

Rayon → trend from commodity to speciality

Aramid → limited use

*** First pneumatic tire**

- **Flax 1888**
- **Cotton 1910**
- **Rayon 1923**
- **Nylon 1947**
- **PET 1962**
- **Steel 1936(1970)**

*** Introduction of new materials since 1980 failed**

TIRE CORD

HYOSUNG

Requirements

Tire requirments	Cord requirements	Key Factors
Performance		
– Treadwear	Modulus, Shrinkage & Creep (Dimensional Stability)	• Strength
– Handling	Modulus, Shrinkage & Creep (Dimensional Stability)	
– Rolling Resistance	Strength, Modulus	• Modulus
– Noise	Modulus	
Weight	Strength, Density	• Dimensional Stability
Uniformity	Modulus, Shrinkage & Creep (Dimensional Stability)	
Durability	Strength, Fatigue	• Fatigue
Manufacturing	Residual Force, Strength	
Value	Cost/Performance	

과 제

경량화에 의한 회전 저항 감소

- 타이어의 연비개선
- 경량화의 방법
  - 사용재료의 절감
  - 코드용 원사 및 고무의 물성 개선

조종안정성 및 승차감 향상

- 고속 내구성
- **Uniformity** 개선
  - 그린타이어 형태 변경 및 고강도코드 사용
  - 성형법 개선
- 소음 절감
  - 타이어 패턴,고무, 코드 섬유의 재질 변경

TIRE CORD

HYOSUNG

Comparison

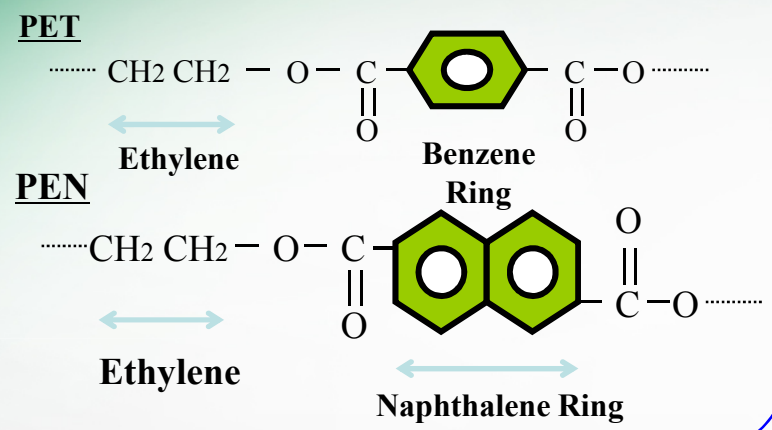
Cord prop.	Tire prop.	NY6	N66	PET	PEN	Rayon	Lyocell	Aramid	Steel
Strength	Pressure	◎	◎	◎	◎	△	△	◎	◎
Elongation	Impact	◎	◎	○	○	○	△	△	◎
Modulus	Maneuverability Ride comfort	△	△	○	◎	○	◎	◎	◎
Shrinkage	Uniformity	△	△	○	◎	◎	◎	◎	◎
Fatigue	Endurance	◎	◎	○	○	△~ ○	△	△	○
Adhesion	Endurance	◎	◎	○	○	◎	◎	○	○
Chemical	Endurance, Curing	○	○	△	○	○	○	○	○
Creep	Wear	△	△	○	○	○	○	◎	○
Moisture	Manufacturing	○	○	○	○	△	△~○	○	△
Tm	Endurance	△	○	○	○	◎	◎	◎	○
Price	Cost	◎	○	○	△	△	△	△	○
Advantage		fatigue low heat strength low cost	fatigue low heat strength	low cost	high mod shrinkage	high mod shrinkage adhesion	high mod shrinkage adhesion	high tena high mod high Tm shrinkage	high ten High mod
Disadvantage		low mod shrinkage low Tm strength↓ in curing	low mod shrinkage strength↓ in curing	aminolysis adhesion heat gen.	high cost	high cost low tena strength↓ in wetting	high cost low tena fatigue strength↓ in wetting	high cost fatigue	weight

TIRE CORD

HYOSUNG

Polyethylene naphthalate (PEN)

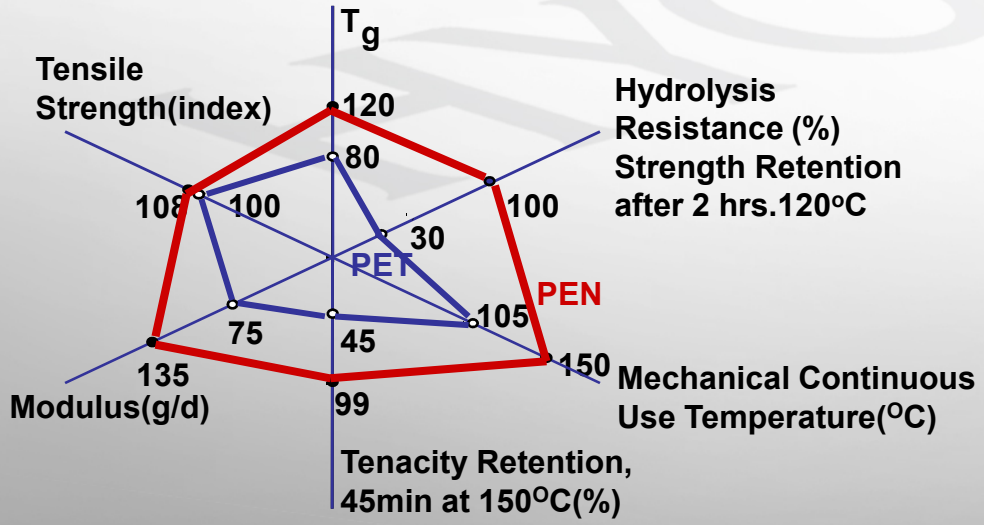
[*Chemical Structure*]



Naphthalene Ring is more rigid.

⇩

High Modulus & Low Shrinkage

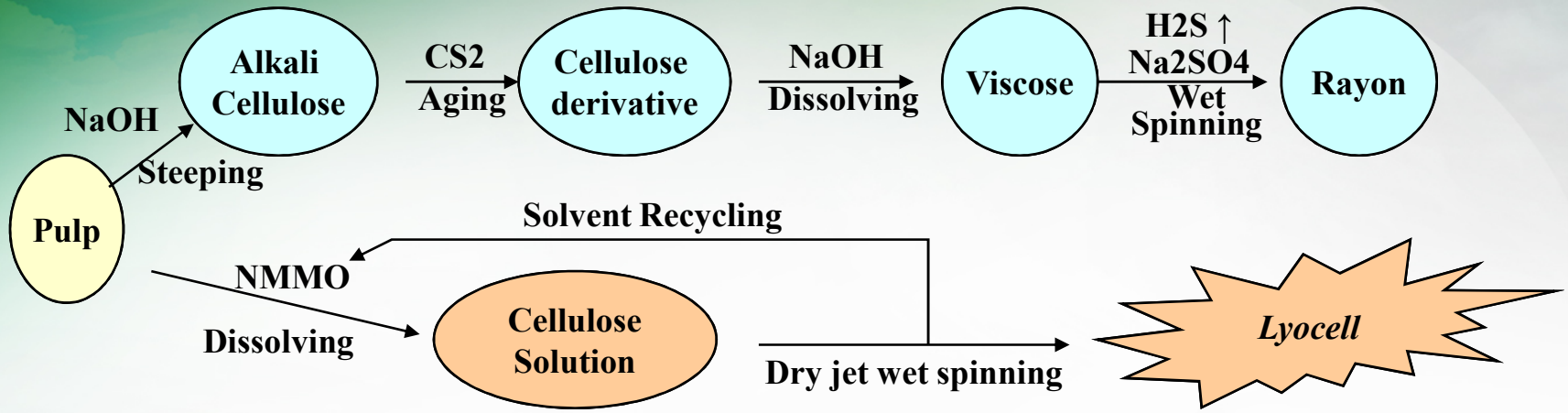


- **Advantages**
  - **Higher Tg**
  - **Higher Modulus**
  - **Thermal Resistance**
  - **Chemical Resistance**

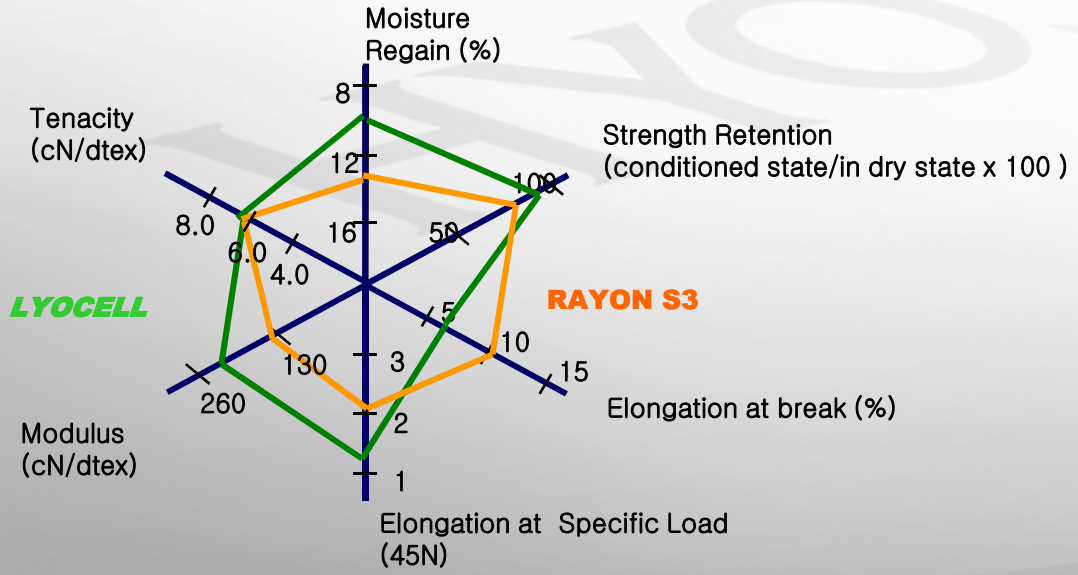
TIRE CORD

HYOSUNG

Lyocell



Lyocell process is very simple, friendly to the environment



Advantages

- higher modulus
- lower elongation
- susceptible to humidity

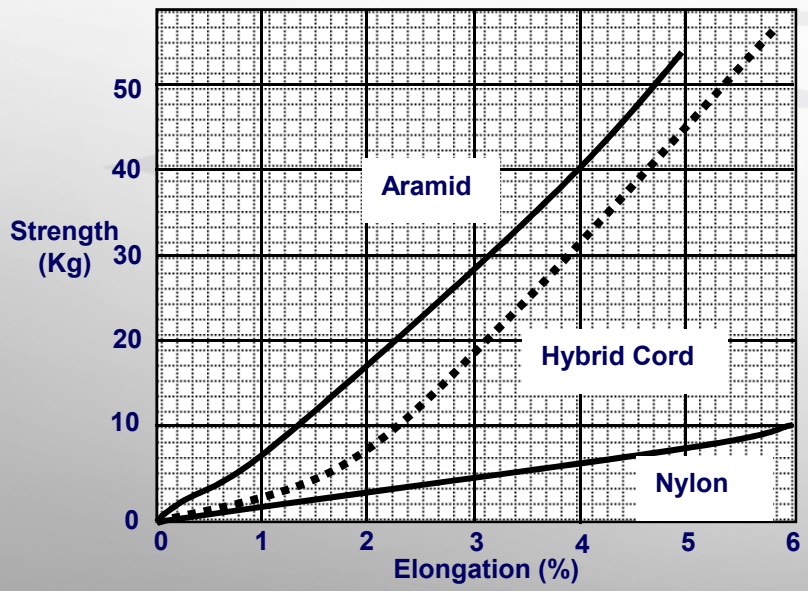
TIRE CORD

HYOSUNG

Hybrid Cord (Aramid/NY66)

Aramid Tire Cord

- **Advantages**
  - High Strength
  - Higher Modulus
  - Thermal Resistance
- **Disadvantages**
  - Low Elongation
  - Poor Fatigue Resistance
  - High Price



- **Hybird cords offer**
  - improved fatigue resistance
  - higher elongation
  - lower Modulus
  - controlled shrinkage
  - better or equivalent strength to cost ratio

TECHNICAL YARN

HYOSUNG

		Category	Application
PET Technical Yarn	KOREA 38,400 T/Y CHINA 13,300 T/Y	Coated & Uncoated Broad Fabrics	✓ Roofing Membrane, Tarpaulin Signboard, Awnings/Tents, Boat, etc.
		Narrow Woven & Rope/Nets	✓ Sling Belts, Harness, Strap Rope, Hose, Nets, etc.
		Mechanical Rubber Goods (MRG)	✓ Conveyor Belts, Hoses Power Transmission Belts, etc.
		Geosynthetics Fabrics	✓ Geogrid, Geotube, Geostrap Geocomposite, etc.
		Automotive Seat Belts (ARS)	
		Spun Dyed Black Yarn	✓ Fishing Nets, etc.
Nylon66 Industrial Yarn	KOREA 3,000 T/Y	Sewing Thread	
		Airbag	

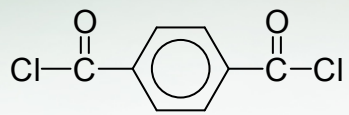
파라아라미드 슈퍼섬유

HYOSUNG

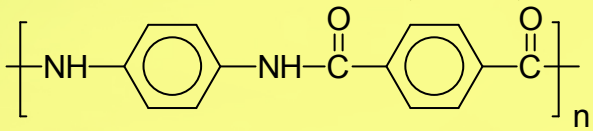
Introduction

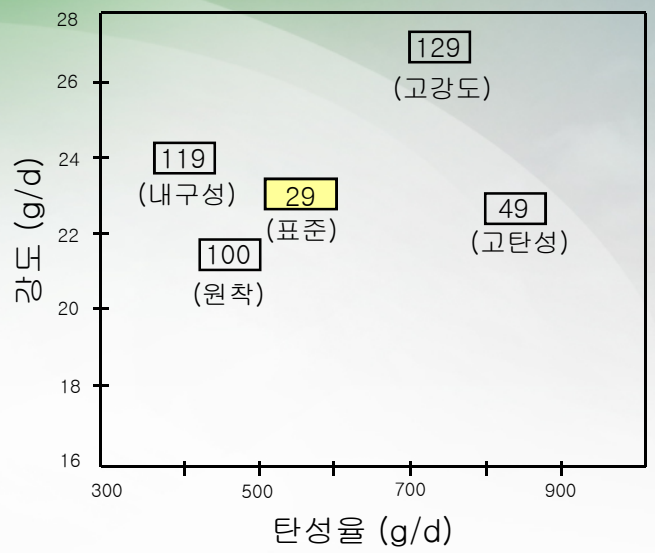
p-Phenylene diamine (PPD)

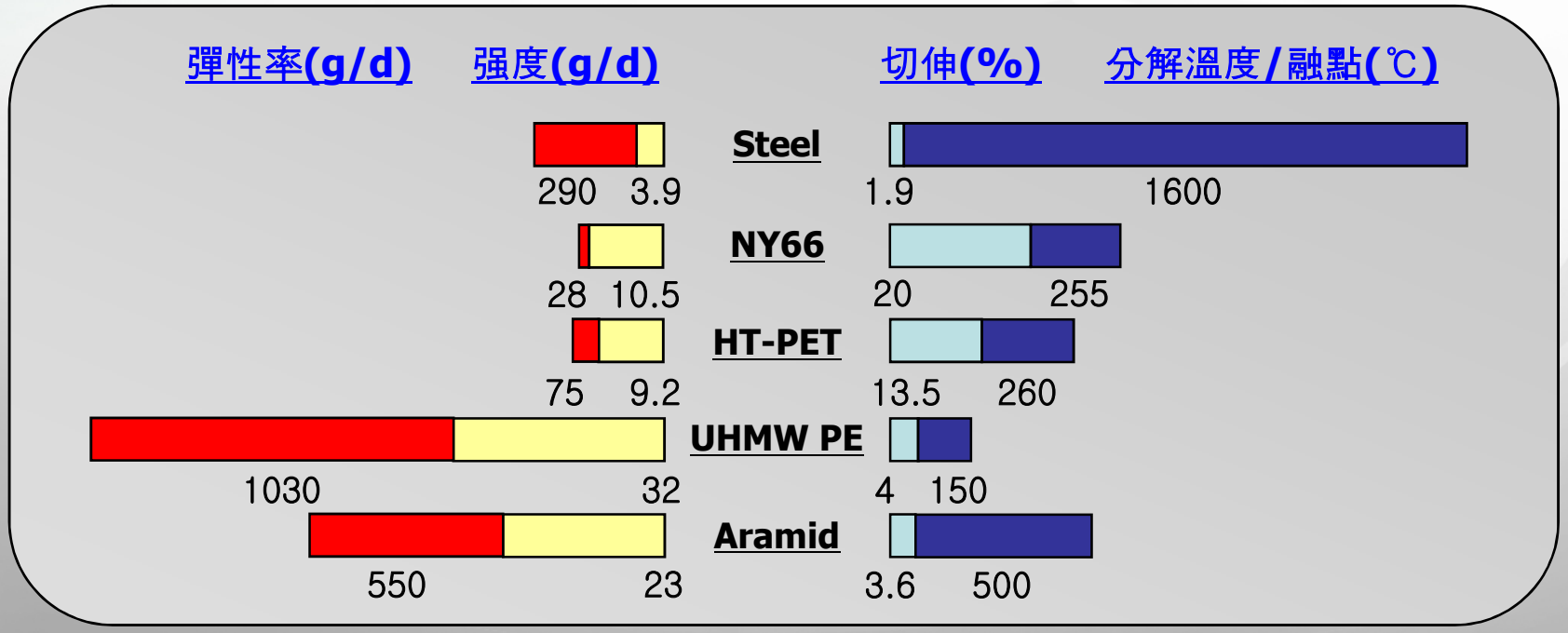
Terephthaloyl chloride (TPC)



파라아라미드 Resin (PPD-T)







파라아라미드 슈퍼섬유

HYOSUNG

Applications / Requirements

1次 形態	2 次 形態			主要 用途	要求 物性
Filament	無撚			FOC Tension member, Rope	高彈性率, 低伸度, 低Creep
			熱硬化樹脂 處理	FOC Tension member	
		高彈性織物	接着硬化劑(Epoxy) 處理	골프클럽 等 Sports部品	高彈性率
	撚絲			樹脂 호스 補强用	高强力, 低伸度
			接着劑 處理	고무호스 補强用	
	(TM=1.0~3.0) 高强力Cord	高彈性率 織物		Concrete 補强	高彈性率, 高强力
		高强力 織物		防護衣料, 방탄조끼(Hard type)	高强力, 低伸度
			接着劑 處理	Rubber, Dam用	
			接着劑(RFL) 處理	콘베이어 벨트	輕量, 高强力, 低伸度
			熱硬化 樹脂 處理	헬멧, 방탄조끼(Hard type)	輕量, 高强度, 高衝擊强度
	撚絲 (TM=2~3)		接着劑(RFL) 處理	전동벨트	高强度, 低伸度, 低Creep
	撚絲 (TM=6.5)	織物	接着劑(RFL) 處理	自動車用, Motorcycle用 Tire	輕量, 高强度, 高伸度
Staple fiber				펠트(felt)	耐熱
	紡績絲	編物		안전장갑, 防護衣料	耐切創性, 耐熱
		織物		필터, 防護衣料	耐熱
			接着劑(RFL) 處理	자전거用 Tire	輕量, 高强度
			알루미늄 蒸着	耐火服	輕量, 耐熱
Chopped fiber				電氣絶緣用紙	低誘電率
Pulp				석면 代替 - 브레이크 패드, 가스켓 - 브레이크 라이닝	高强度, 耐熱, 耐磨耗性

파라아라미드 슈퍼섬유

HYOSUNG

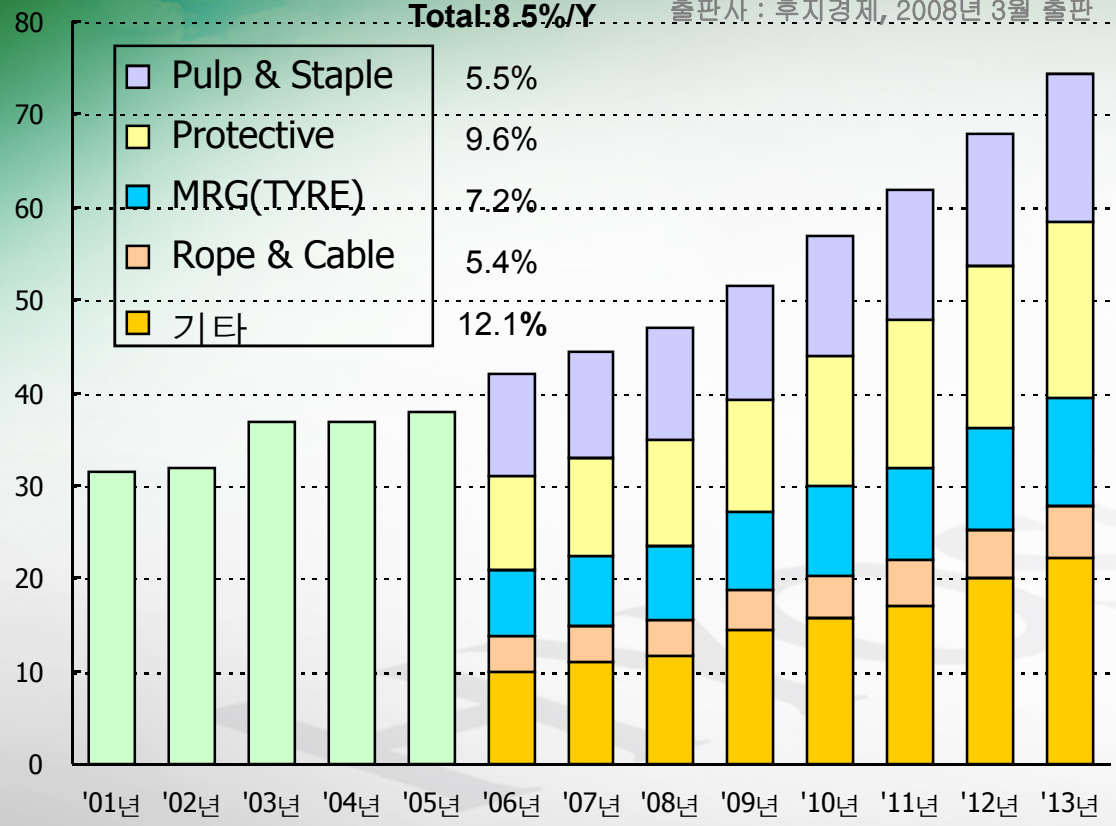
Applications

CAGR('06~'13)

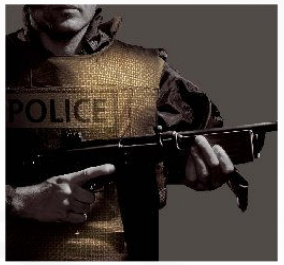
Total:8.5%/Y

출처 : "고기능성 섬유시장 실태 총 조사 2008"

출판사 : 후지경제, 2008년 3월 출판



Brake linings & Clutch facings



Ballistic-protection

Tires

Transmission belts

Composites for aerospace, marine, sports and leisure

Ropes and cables

파라아라미드 슈퍼섬유

HYOSUNG

Vision

2003.11	R & D Start
2006.01	Pilot Production Line 완공(안양 연구소)
2009.08	Commercial Line Start(1,000톤/년)

품종 확대

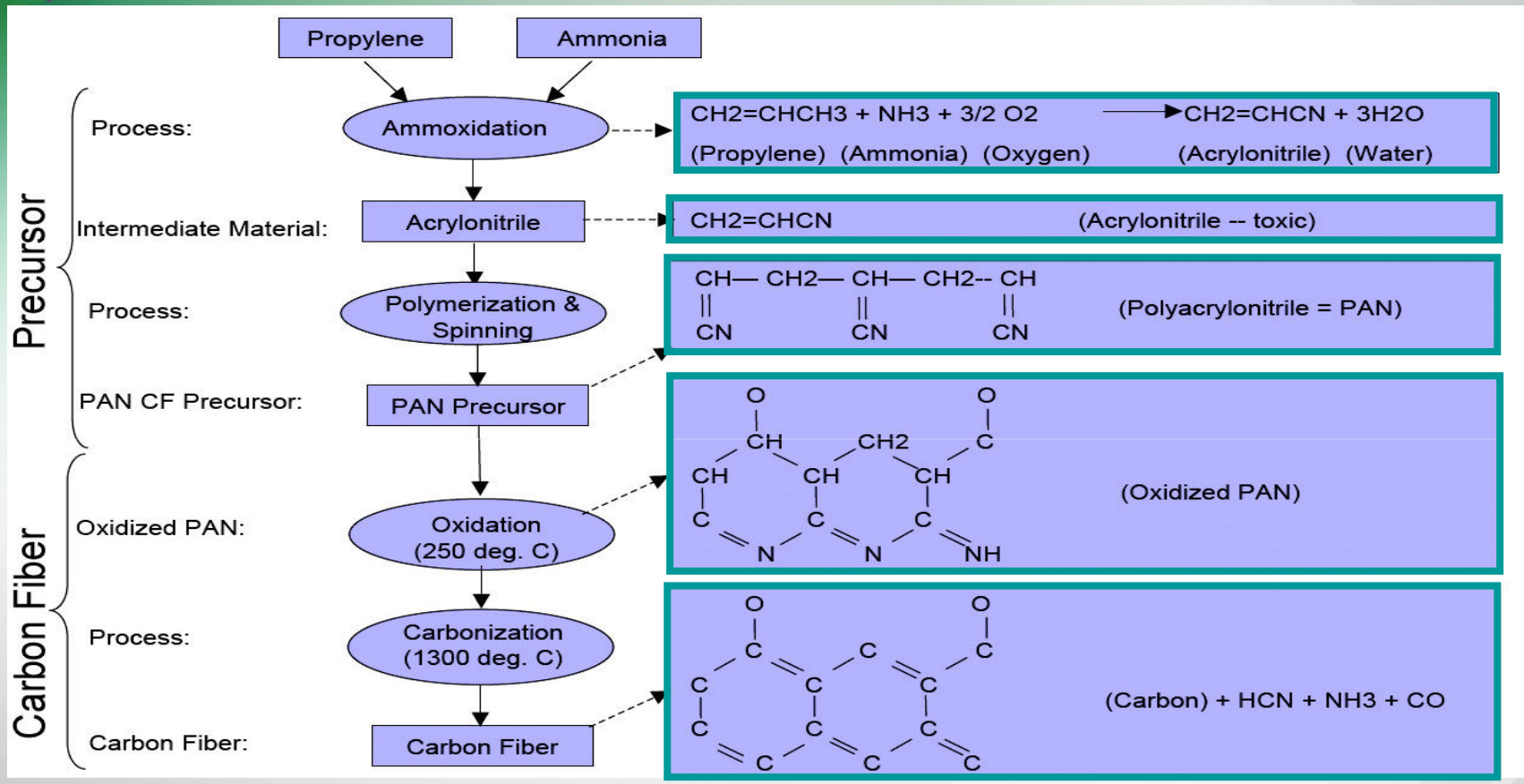
증설

Aramid Fiber Global Player

CARBON FIBER

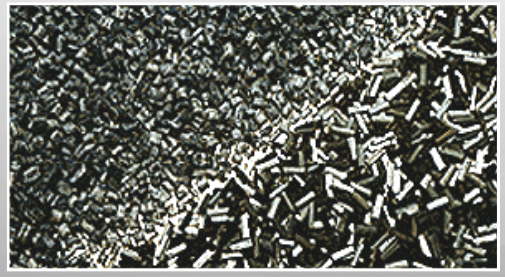
HYOSUNG

Introduction



Tow/Roving

Short fibers



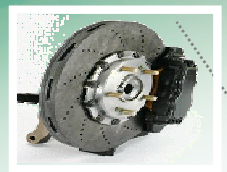
Fabrics

CARBON FIBER

HYOSUNG

Applications

Pressure Vessel



Brake Disc

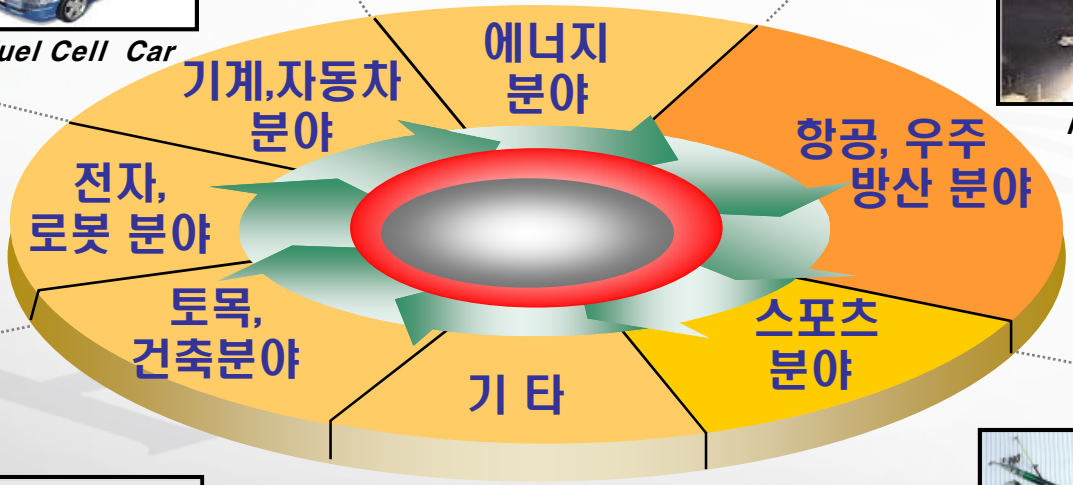
Fuel Cell Car

Note Book

LCD Roller

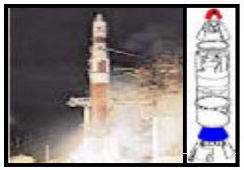
Supercapacitor

Wind Energy



A350 /B787

Stealth

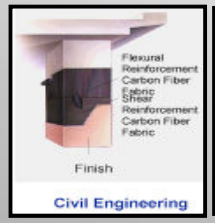


Missile

Carbon Bomb

Stealth ship

Armored car



Construction

Yacht Handle

Seas Fabric

Fishing rods

Golf

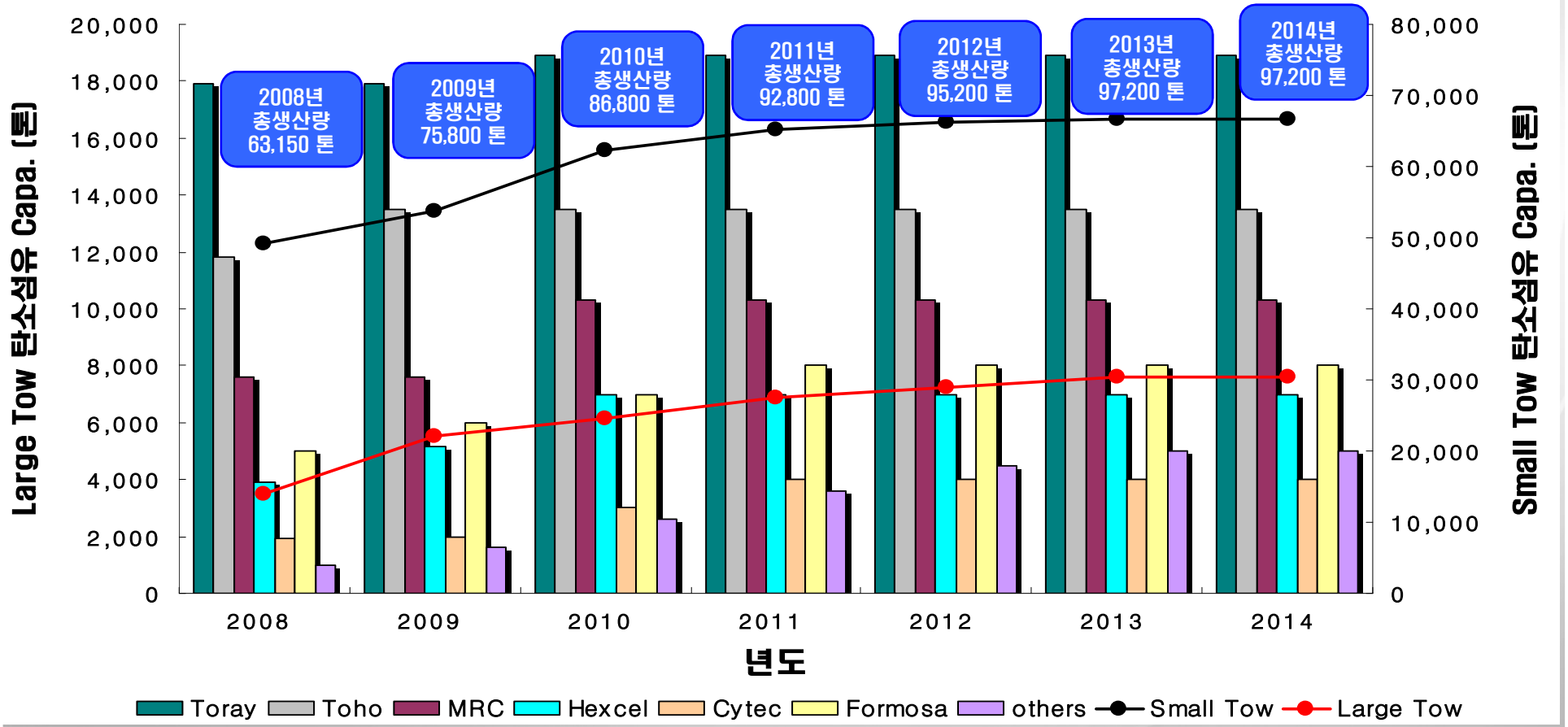
CARBON FIBER

HYOSUNG

탄소섬유 (PAN) 생산량

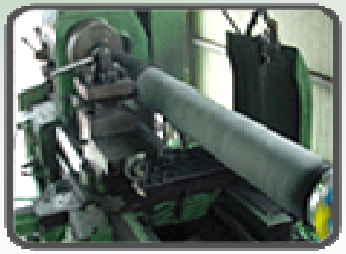
- CF시장은 PAN계가 94%, Pitch계가 6%
- Small Tow는 일본 3사, Large Tow는 Zoltek과 SGL이 Major임

효성
Carbon Fiber Global Player



Source : Carbon Fiber 2008 Conference (2008년 12월, USA)

비전



기존 사업의 녹색 부가가치화

및

신규 녹색 성장동력 발굴

신섬유

HYOSUNG

슈퍼섬유

- 탄소섬유
- 아라미드섬유

친환경섬유

- Lyocell
- REGEN

나노섬유

- Carbon Nanotube
- Nano Fiber

스마트섬유

- 박막태양전지기술
- CNT ➡ 투명전극소재

연구개발 전략

HYOSUNG

미래 신성장 동력을 창출하는

Global R&DB

기존기술 강화

월드베스트 역량

핵심 신규기술 확보

차세대 시장 조기 진입

Open Innovation

사업실패 극복전략

Speed 경영/ 사업화 촉진 방안

신시장/ 신제품 개척 전략

프로젝트 성공율 향상 전략