Introduction of New Large Tow Carbon Fiber Products and PCM* Technology

* Prepreg Compression Molding

Good Chemistry for Tomorrow®
Creating better relationships among people, society, and our planet.

MITSUBISHI RAYON CO.,LTD.

Mitsubishi Rayon

Carbon Fiber Business

for Industrial applications

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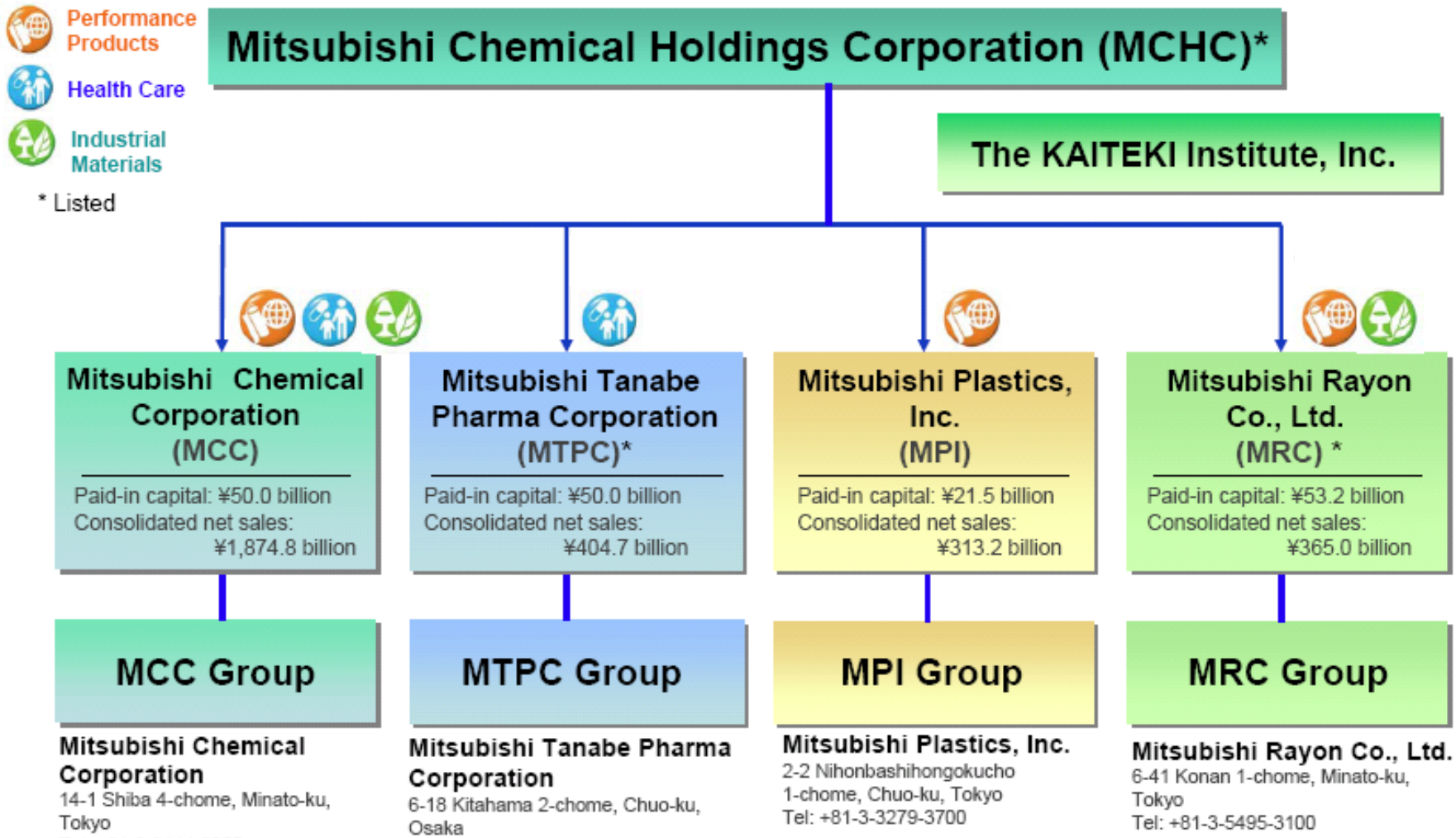
MCHC Group Organization



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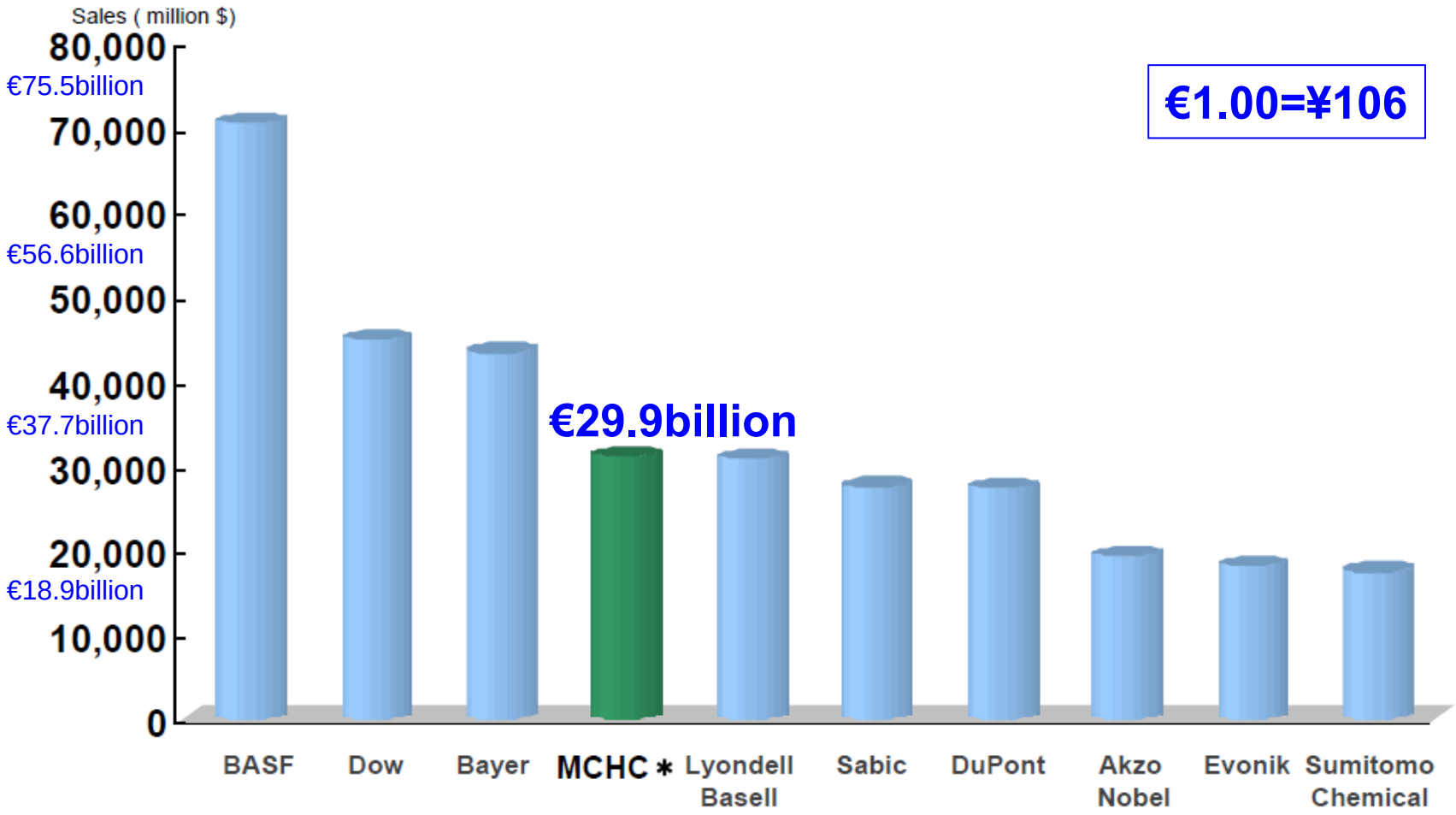
Tel: +81-3-5495-3100

Figures for consolidated net sales and paid-in capital are for the year ended March 2010.

Chemical Industries Global Ranking



＊A total sales of MCHC and MRC as of March 2010
Source: Latest data for each company from Thomson Reuters FORTUNE Global 500 (as of September 2010)

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MRC Company Profile

Foundation	Year 1933
Capital	€502 Million
Employee	8,203
Consolidated Sales Amount	€4.51 Billion
	(€1.00=¥106)

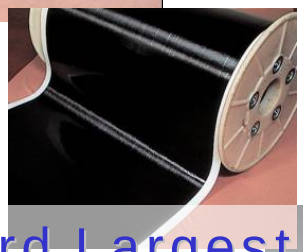
Main Business

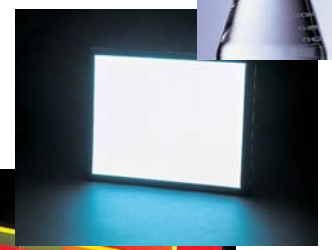
1. Specialty Resin and Chemicals
2. Acrylic Fiber, AN
3. Carbon Fibers, Composites
4. Synthetic Fibers, Membrane

MRC Sales Breakdown

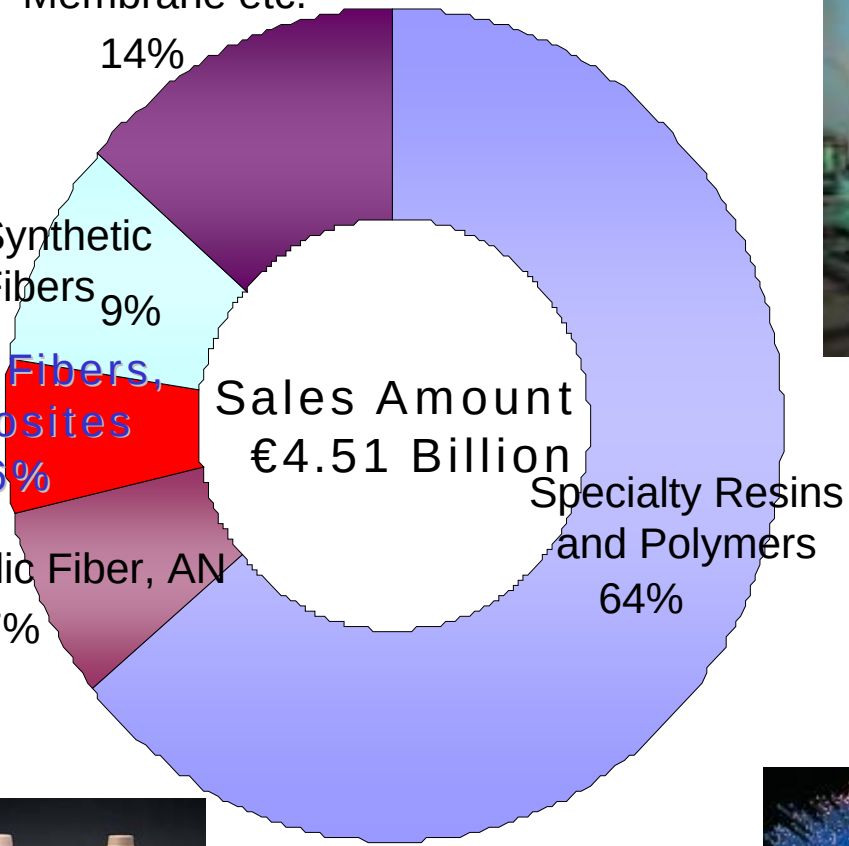












The 3rd Largest Carbon Fiber Manufacturer

As of Mar 2011

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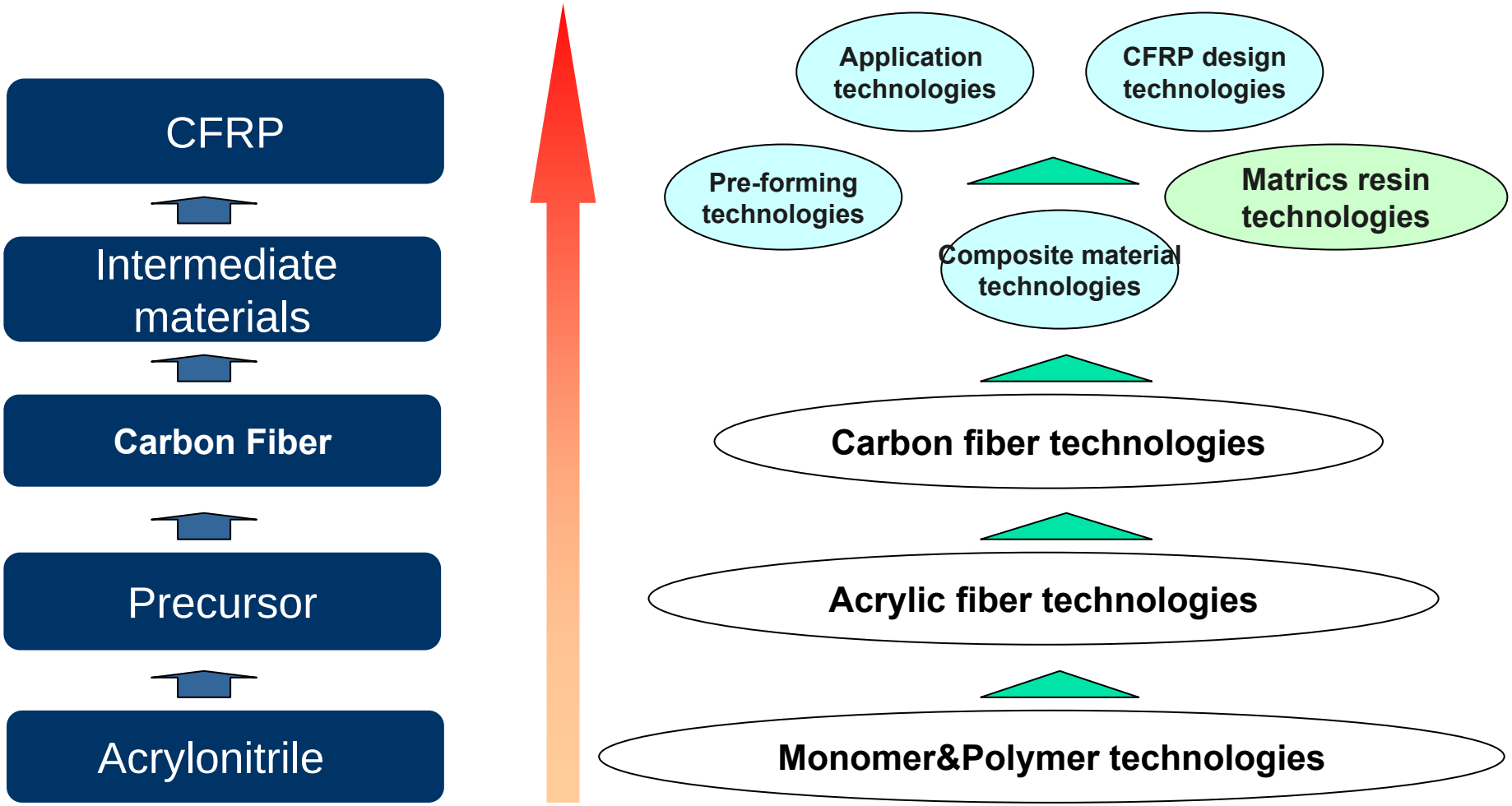
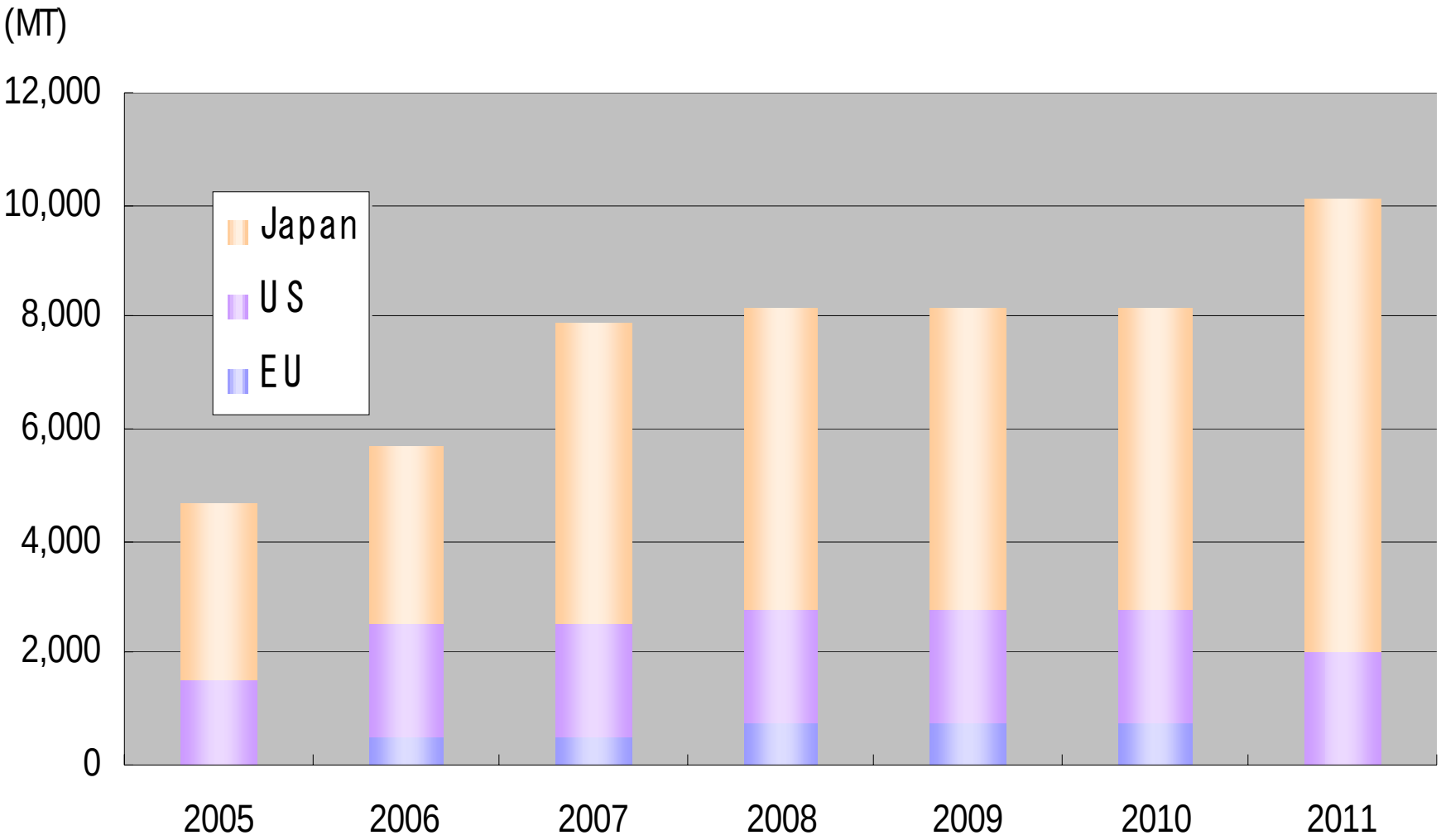
Features of MRC carbon fiber business

Vertical integration



MRC Carbon Fiber Production Capacity



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Mitsubishi Rayon

Premium Carbon Fiber

for Industrial applications

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New product concept

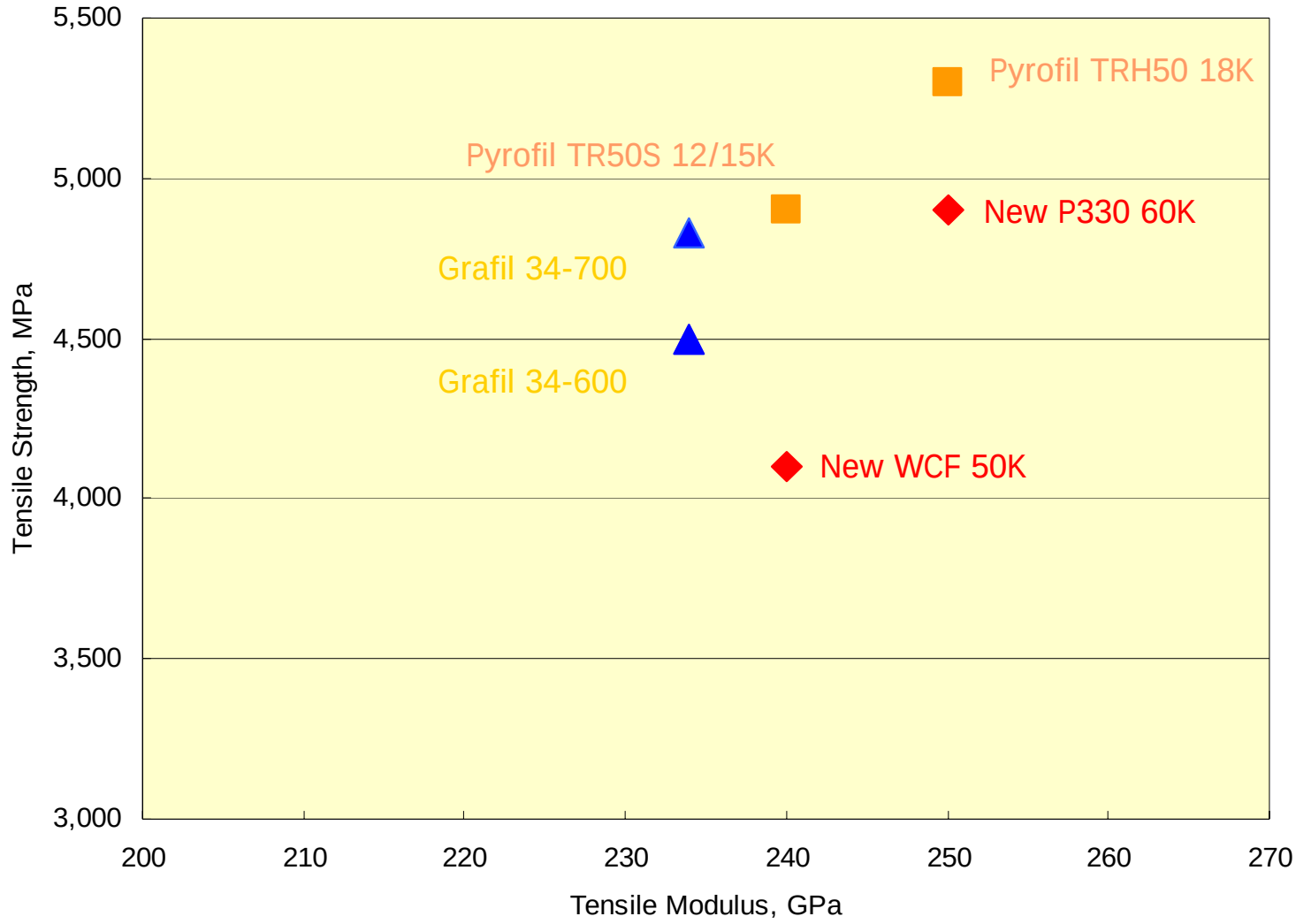
Product required for growing industrial applications

- **Good process-ability, high performance (small tow like)**
- **Tightly controlled quality (small tow like)**
- **Large tow for high productivity at sites**
- **Good avaliability and affodability**

Our new product will change
conventional Large-tow perception in Market

"Larger Filament Count,
but performs as small tow or even better"

Property chart



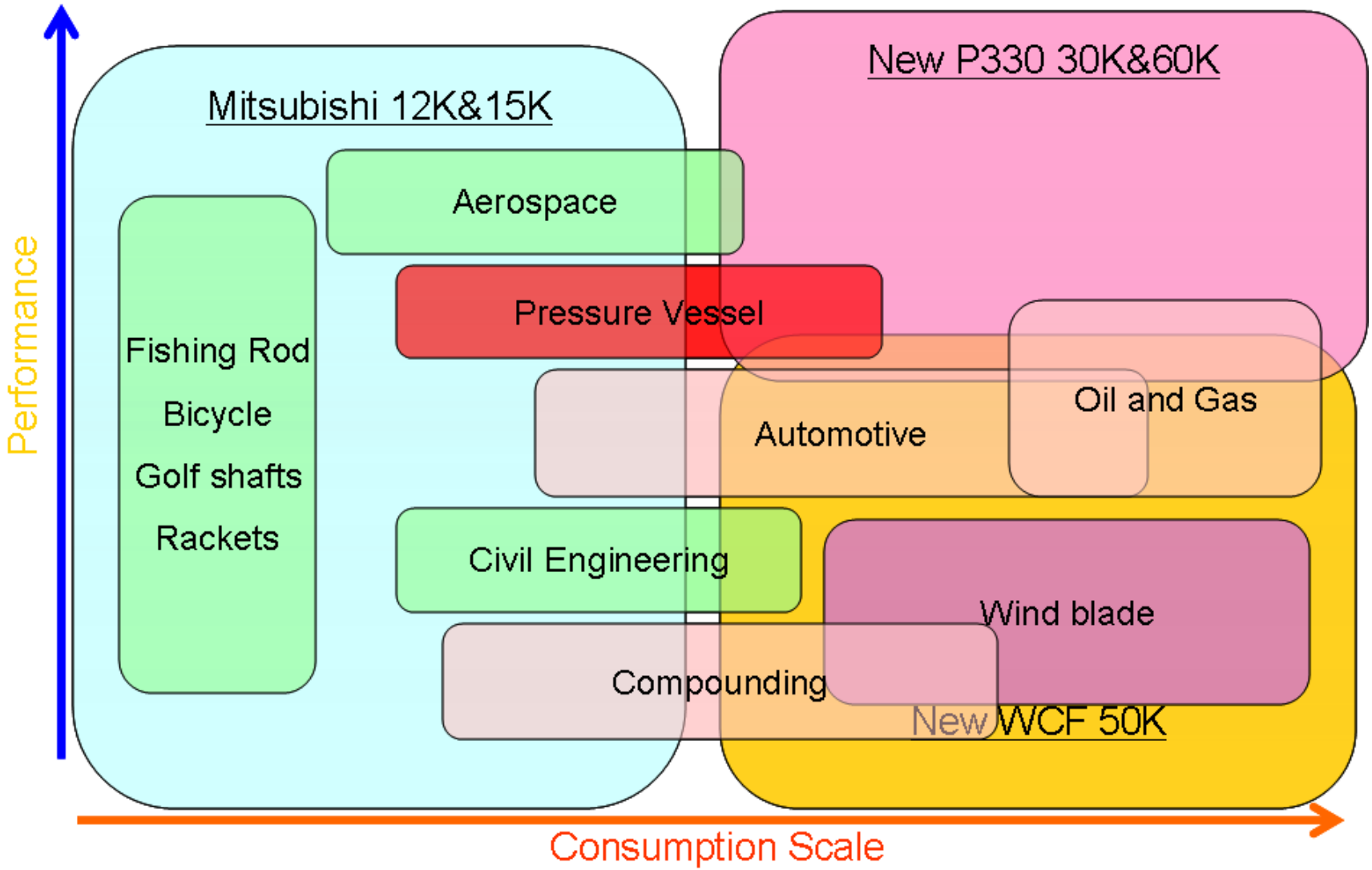
Products

Name	Filament Count	MUL (mg/m)	Density (g/cm3)	Tensile Modulus GPa	Tensile Strength MPa
P330 60K	60K	3,200	1.81	250	4,900
WCF 50K	50K	3,750	1.81	240	4,100

Spool length: 2,500m (WCF and P330)
Sizing: Epoxy based sizing

P330 series
P330 series performs as our standard small tow (i.e. High strength fiber TR50S/TRH50), however the filament count is larger (50-60k). Comparing with standard small tow fibers (less than 24K), P330 series has better process ability for large composites and performs like standard small tow. We believe that this product will push the technical envelop in carbon fiber market. This new plant will not only be the first plant to produce high performance large tow in earnest over the world, but also it will be the largest carbon fiber plant (2,700t/Y) in capacity in history.

New products from Mitsubishi Rayon



Evaluation Data (Prepreg)

		P330 60K	TR50S 15K
Tensile Strength	MPa	4,906	4,871
Tensile Modulus	GPa	249	244
0 Tensile Strength *	MPa	3,019	2,681
0 Tensile Modulus *	GPa	147	136
0 Compression Strength *	MPa	1,488	1,315
0 Compression Modulus *	GPa	131	123
90 FlexualStrength	MPa	153	136
LSS	MPa	93	94

Strand Test　　Resin:MRC #350

*Vf60% basis culculation

Good process-ability and less fuzz

WCF 50K data to be available, initial result shows
slightly higher compression properties comparing with P330 60K

Evaluation Data (Filament Winding)

P330 60K has similar properties to the ones of TRH50 18K which has been selected/applied for various projects (mainly pressure vessels from small to large)

P330 60K helps improve productivity at customer's site (e.g. the number of spools can be minimized)

MRC internal evaluation result:
- Consistent resin pick-up
- Good tow spredability
- Less fuzz
 (comparing with conventional large tow)

Evaluation Data (UD Fabric)

Evaluation at MRC

Weaving pattern: UD fabric

Weaving Machine: Tsudakoma Rapier

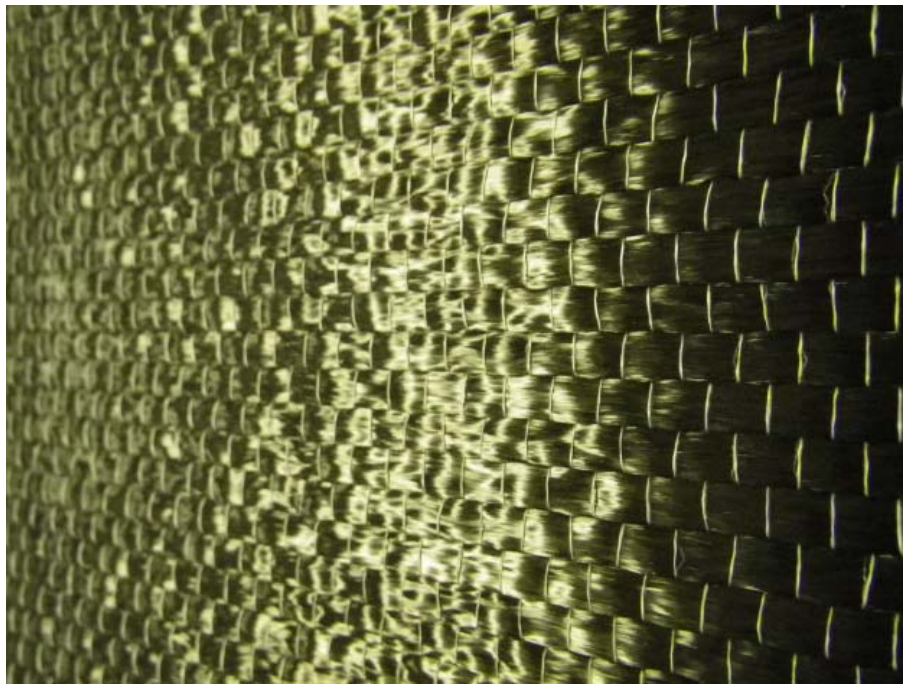
Target FAW: 600g/m2

Warp Yarn (CF): 4.5 ends/inch

Fill Yarn (GF): 8 ends/inch

Warp Yarn Tension: 17kg

Fabric Width: 300mm

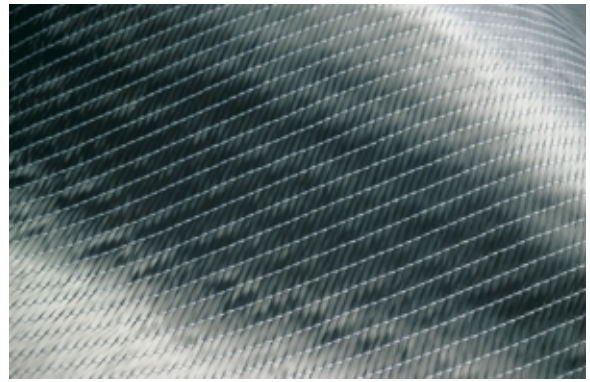


Result

- No Fuzz
- Good spredability

Evaluation Data（BIAXIAL +/-45º CF FABRIC)

- Non-crimped Biaxial Fabric based on 60K.
  2 layers of carbon fibre fabric
  stitched with polyester
  Carbon fibre orientation is +45/-45 degree.
- TRH50 60M exhibits good spread-ability,
  required for light weight fabric



Material	Fiber Type	Fiber Orientation	Nominal Weight (g/m^2)
Carbon Fiber	TRH50 60M	+45°	150
Carbon Fiber	TRH50 60M	-45°	150
Polyester knitting yarns		-	4
Total		-	304

PYROFIL™

PREMIUM LARGE TOW CARBON FIBRE
FOR INDUSTRIAL APPLICATIONS
LARGE FILAMENT COUNT WITH PROCESSABILITY
AND PROPERTIES OF REGULAR TOW

PRODUCT CONCEPT:

- Excellent Processability and High Performance
- Consistent Quality
- High Productivity in Producing Large Components
- Commercial Availability and Affordability

TARGET MARKETS:

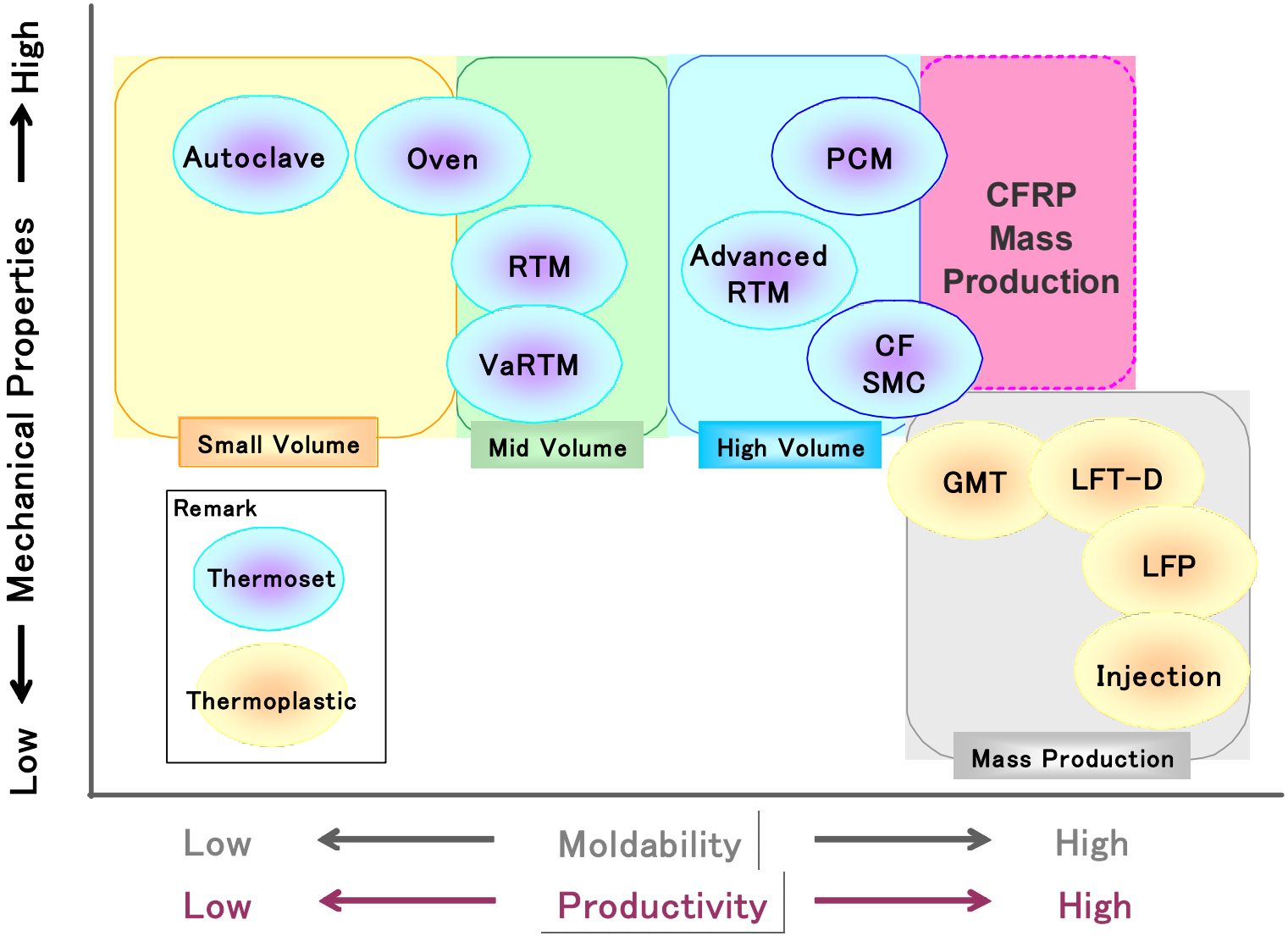
- ***Filament Winding for Pressure Vessels***
- ***Multi-axial Fabric for Automotive Applications***
- ***UD and Multi-Axial Fabrics for Wind Energy Applications***
- ***Large Scale Components Parts where Property to Price Ratio is Critical***

Mitsubishi Rayon

Development of PCM* technology

* Prepreg Compression Molding

CFRP Molding Process

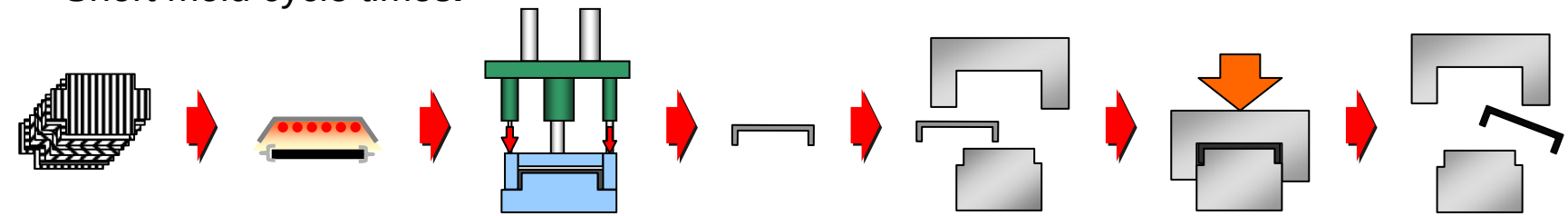


High cycle CFRP molding process

- PCM has a potential for CFRP mass production.

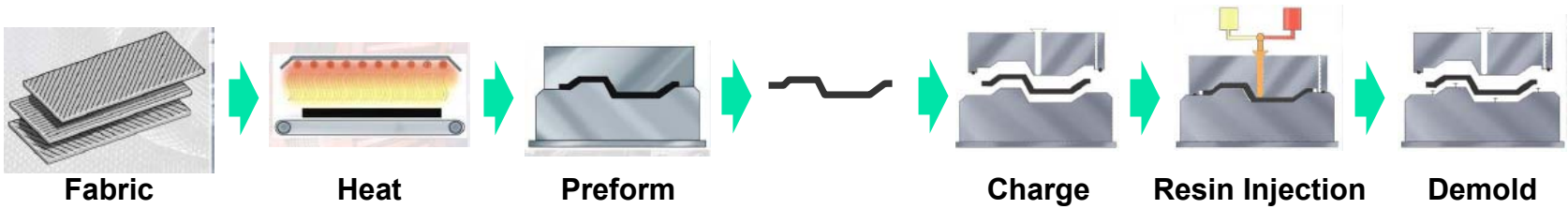
PCM (Prepreg Compression Molding)

Newly developed fast curing prepreg is preformed, and then cured in heated steel tool.
Short mold cycle times.



Advanced RTM

Dry fabric is charged in heated tool, then resin is injected into the mold.
Cycle time can be shortened with fast curing resin system



Prepreg for PCM

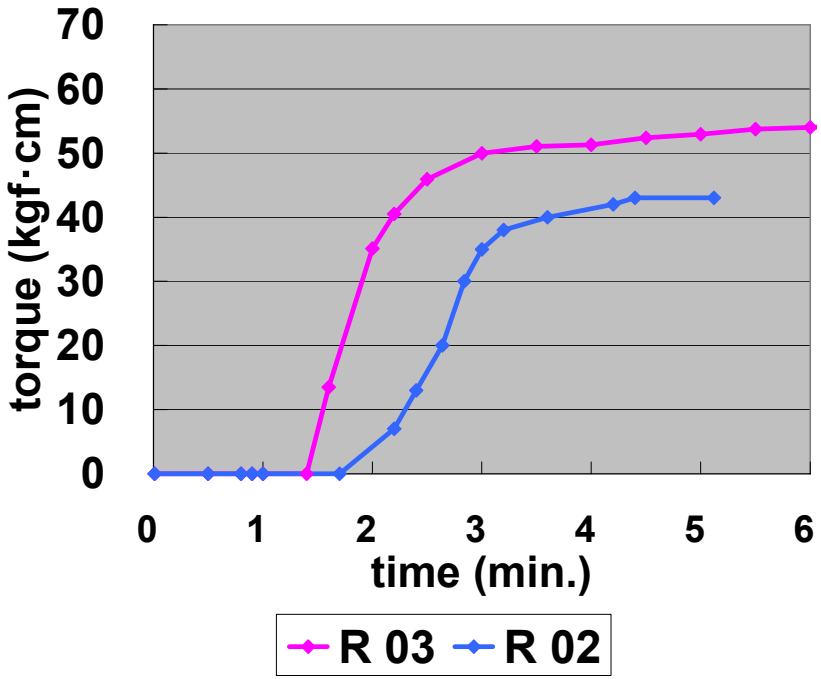
Properties		Developed prepreg			
		R 02		R 03	
Resin type		Bisphenol A type Epoxy resin		Bisphenol A type Epoxy resin	
Gel time @ 140 C	min.	2.0		1.3	
Minimum cure time @140 C	min.	5.0		3.0	
		Typical grade		Typical grade	
CF reinforcement[1)]		UD	Fabric[2)]	UD	Fabric[2)]
FAW	g/m^2	250 or 125	200	250 or 125	200
Resin Content	wt%	30	40	30	40
CF Vf	vol%	59	49	59	49
Specific Gravity		1.54	1.47	1.54	1.47
Other advantage		Good Surface		High Tg	

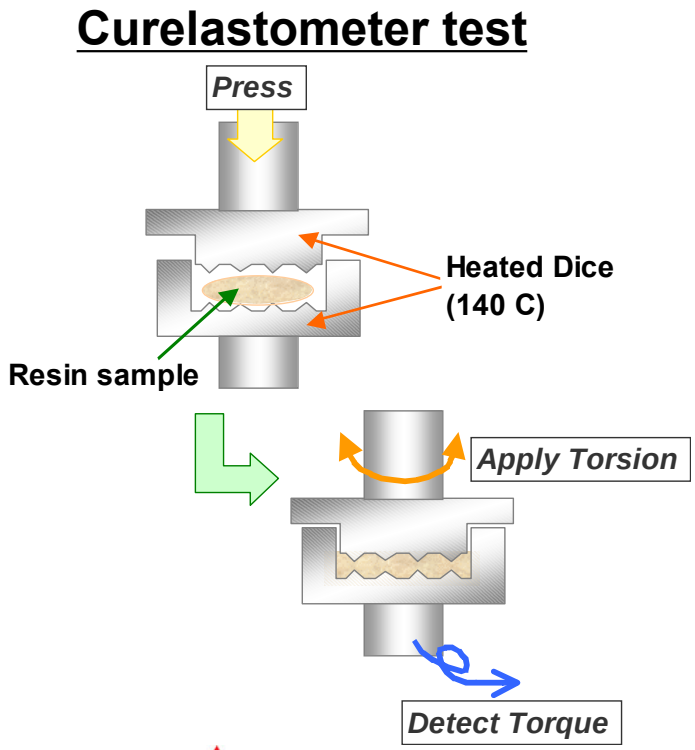
1) TR50S carbon fiber from Mitsubishi Rayon Co., Ltd. is used for all prepregs
Tensile strength; 4900 MPa, Modulus; 240 GPa, Elongation; 2.0%

2) Plain, twill and Satin fabric can be used.

Fast curing formulation

- Resin formulation has been optimized for fast curing
  - Optimized combination of resins and curing agents
  - Curing behavior are evaluated by Curelastometer
    - Curelastometer can measure/monitor resin behavior under conditions similar to actual molding.

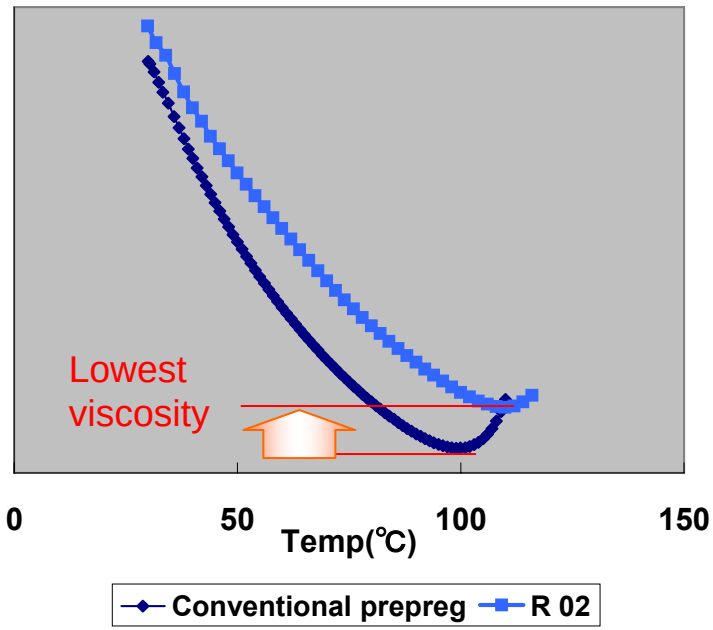




Viscosity control

- Resin viscosity at elevated temperature was optimized for compression molding.
  - Low viscosity of conventional materials at elevated temperature results in excessive resin flow

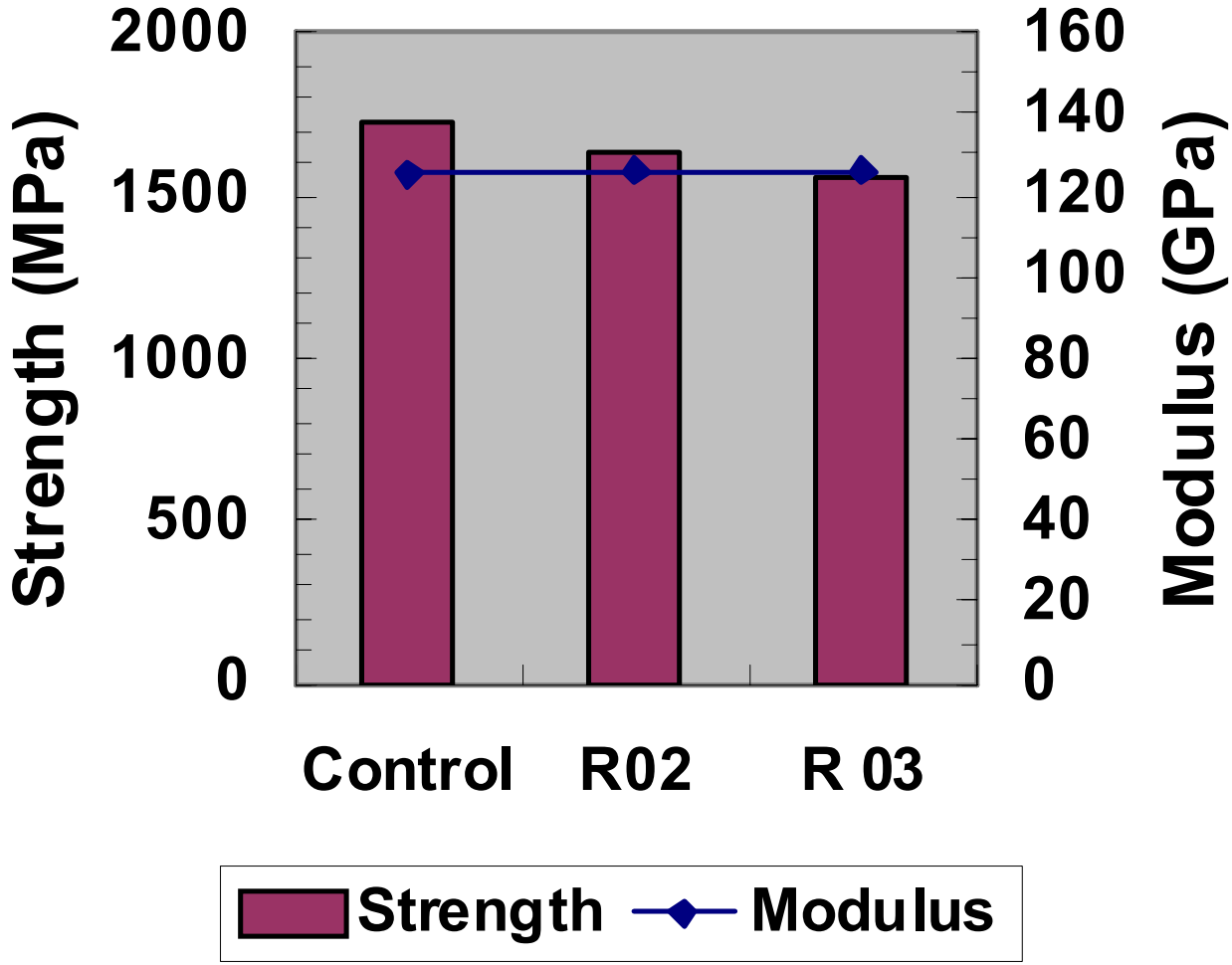
Viscosity at elevated temperature



Problem caused by low resin viscosity

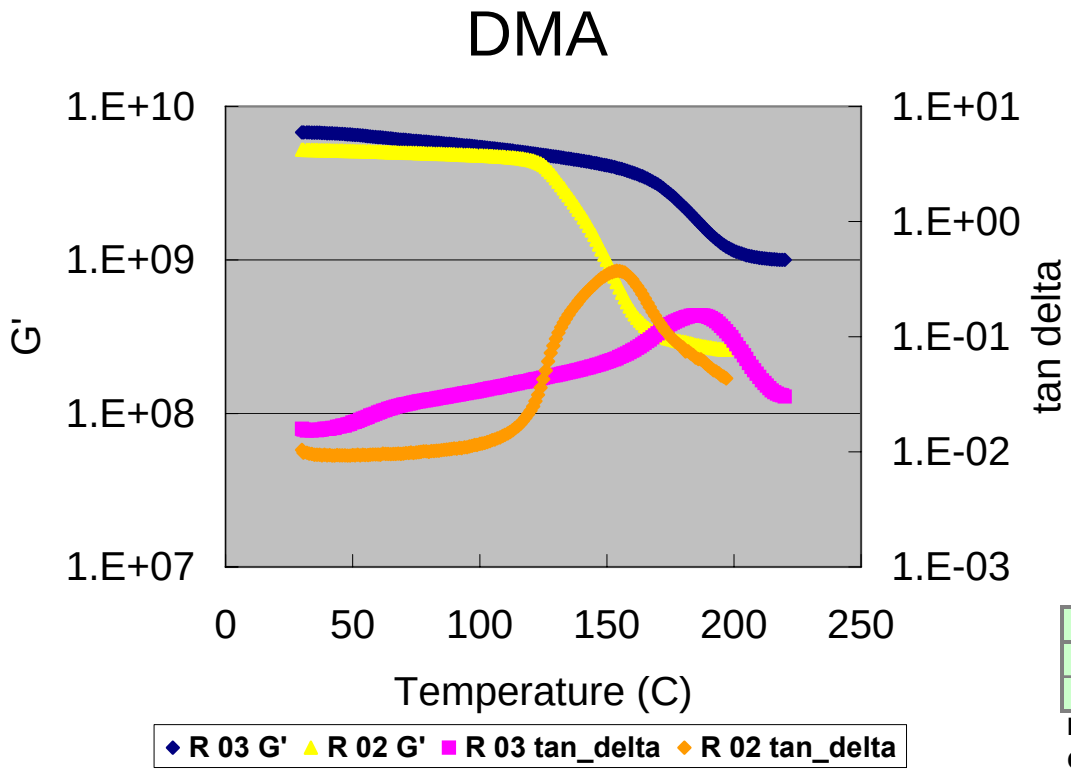
- Bleed out of cavity
- Inconsistent mechanical results
- Fiber distortion
- Poor thickness uniformity
- Poor cosmetics
- Demolding issue

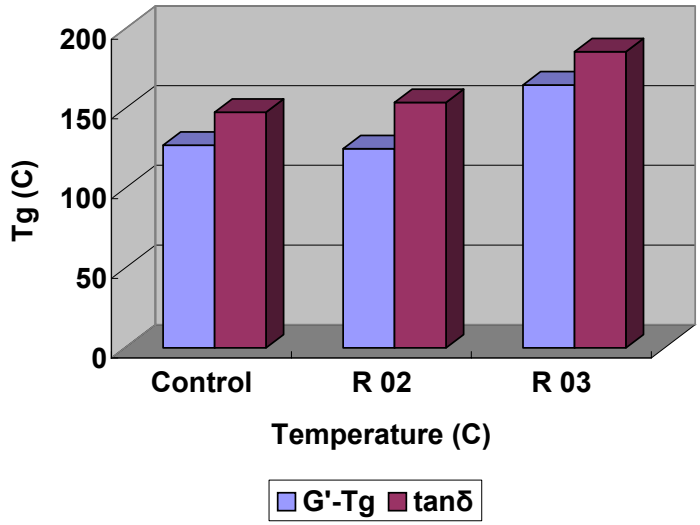
0 degree Flexural strength/modulus



Thermal Analysis

- E' Tg of R 03 is over 160°C
  - R 03 can be used for high temperature applications





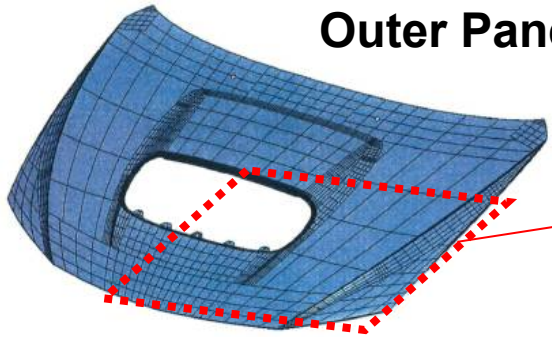
Prepreg	Control	R 02	R 03
G'−Tg (℃)	127	125	165
tan δ (℃)	148	154	186

Molding Condition; 140 C×5min 8MPa
Control prepreg is cured by autoclave

Engine hood model part development

- A quarter part of engine hood was developed to demonstrate feasibility of PCM body panels.
  - PCM outer and CF-SMC inner panels were bonded to produce a body panel structure consisting of two parts.
  - CFRP engine hood is 63% lighter than steel hood.

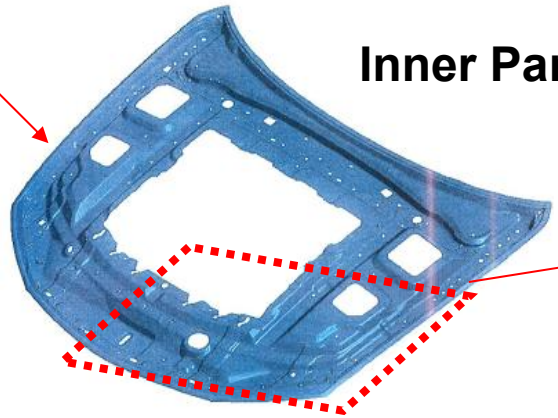
SUBURU Impreza
Steel hood; 14.5 kg
CFRP hood; 5.3 kg
(Whole hood)



Outer Panel

PCM

Part size; 600X600X1.1mm



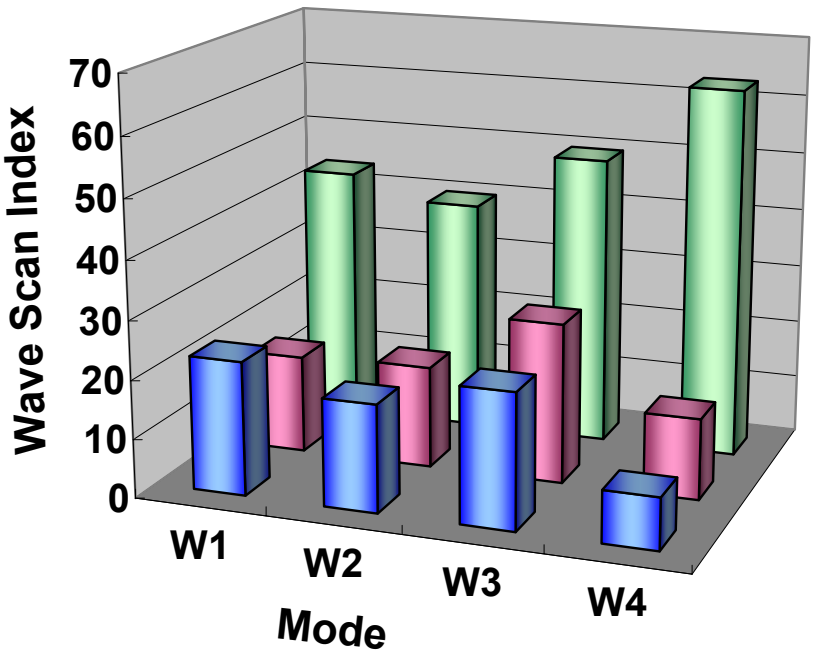
Inner Panel

CF-SMC

Part size; 600X600X1.5mm

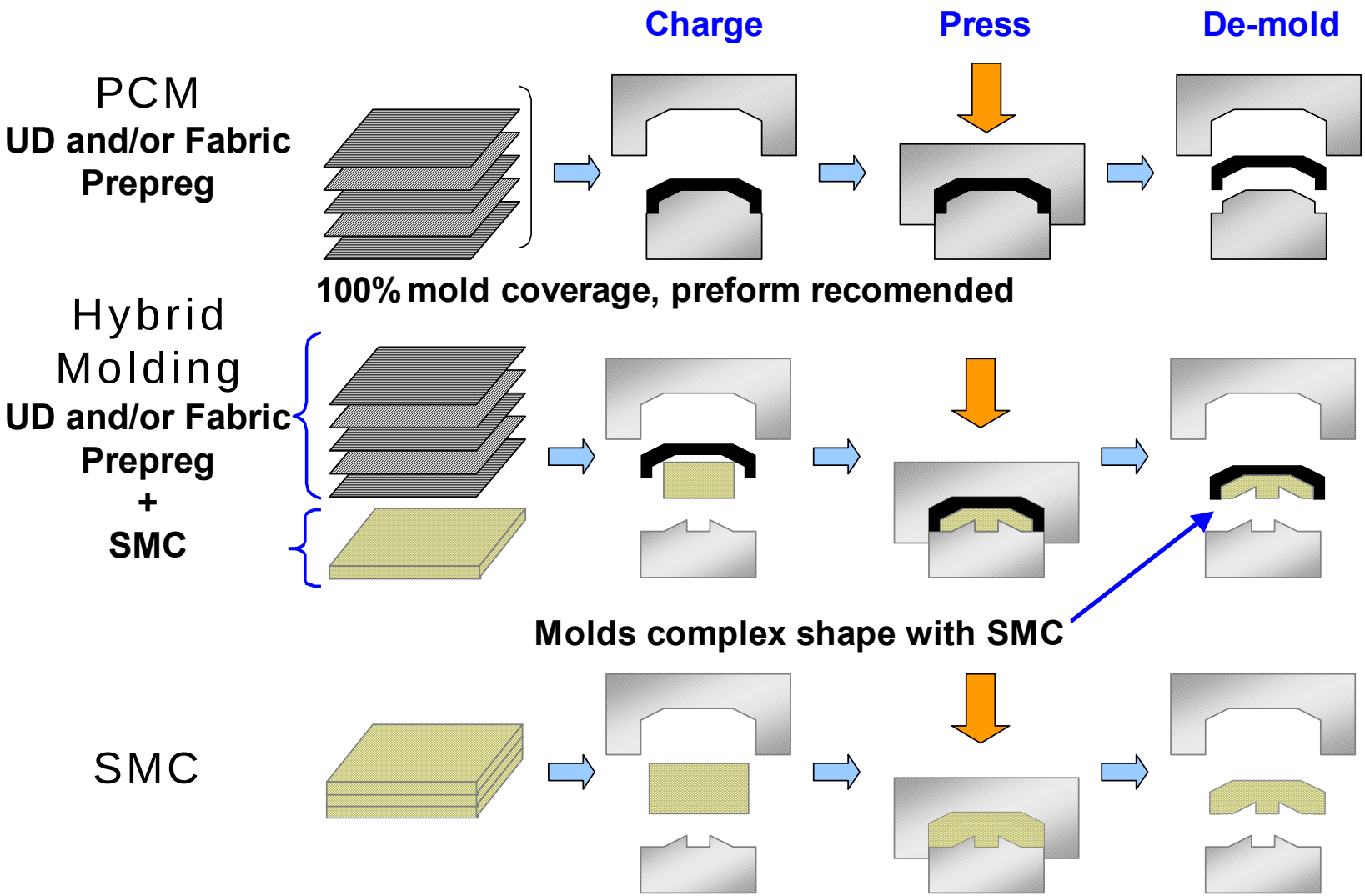
Surface Quality of PCM parts

- R 02 UD Prepreg can achieve Class A surface.
  - Wave scan index of parts molded by PCM is similar to that of typical class A SMC parts.



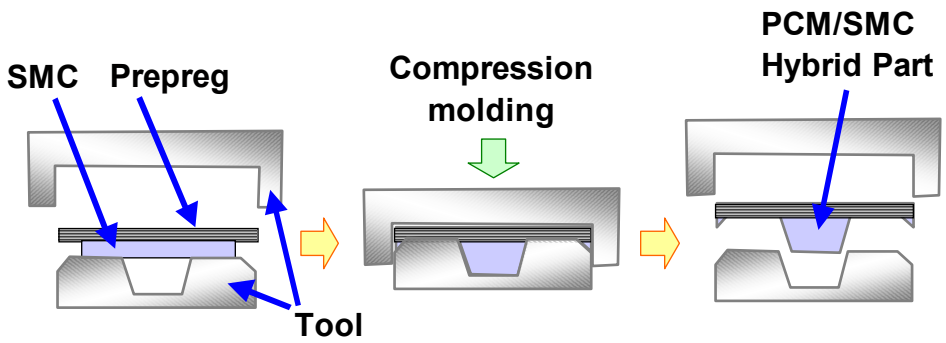
Wave scan index was measured by Wave Scan-T from BYK-Chemie

PCM Molding Process



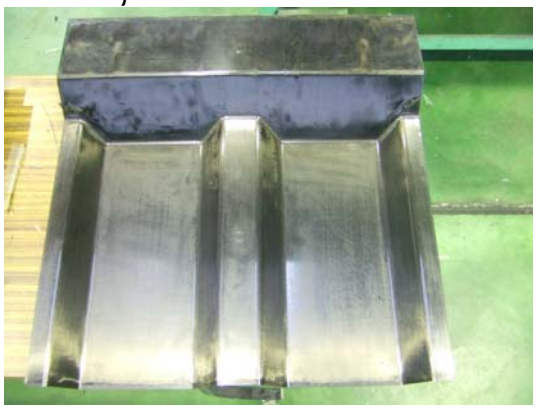
Structural model parts development

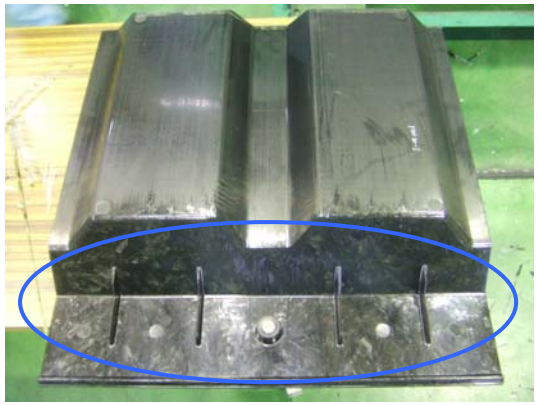
- Structural floor model parts was developed by PCM
  - Hybrid molding of Prepreg and CF-SMC

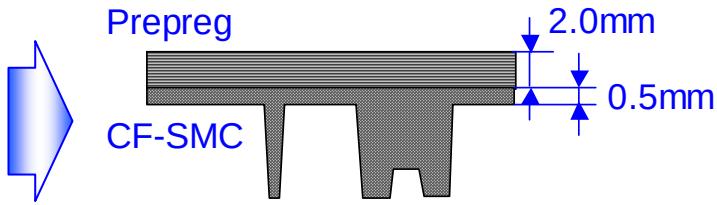


Structural floor model

Size; 500X500mm





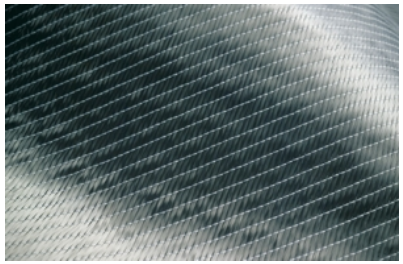


Vertical integration for Automotive applications

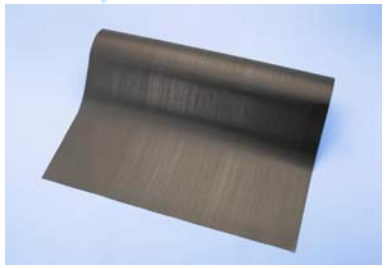
PREMIUM LARGE TOW CARBON FIBRE FOR AUTOMOTIVE APPLICATIONS
- High Performance and Consistent Quality (unlike conventional large tow)
- High Productivity in intermediates material production
- Commercial Availability and Affordability

PCM
Prepreg Compression Molding

RTM



Multi-Axial Fabric utilizing our large tow carbon fiber optimized for RTM process
- Light weight Non-crimped Biaxial Fabric
- Good quality in appearance and performance



Fast Cure Prepreg for Compression Molding
- 3 minutes cure at 140° C
- Controlled viscosity at molding temperature
- Suitable tack at room temperature

PCM (Prepreg Compression Molding Technology)
- Suited for high volume automotive parts production
- Wide Range of applications can be produced by PCM technology
  - Class A finish for outer body painted panels
  - Cosmetically enhanced for superior carbon fabric appearance
  - Structural parts by PCM/CF-SMC Hybrid molding


MITSUBISHI RAYON
To a world standard.
Mitsubishi Rayon is one of the worlds leading suppliers of carbon fibre.
Our driving force is our integrated production system – raw material to finished product - which enables us to respond quickly to changing market needs.
Our new range of P330 carbon fibres is an example of this response in action with a fibre that offers high strength and resilience plus volume production.
The standards set by Mitsubishi are endorsed by customers throughout the world.
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Group Company
Grafil Inc. (www.grafil.com) / Newport Adhesives and Composites Inc. (www.newportad.com)