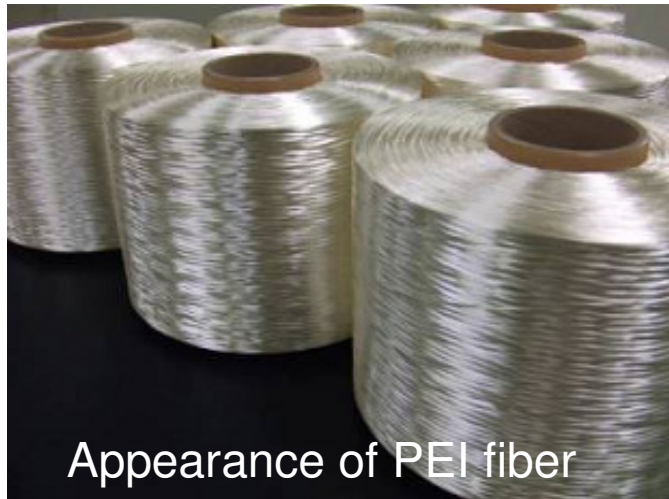


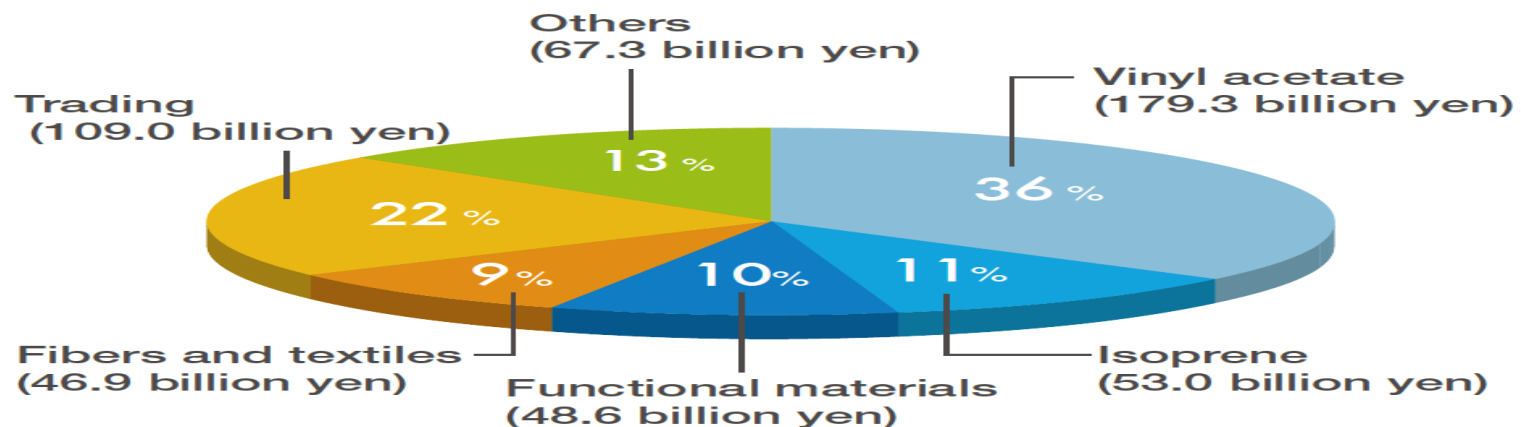
# **High performance thermoplastic composite material derived from “Polyetherimide (PEI) fiber”**



9<sup>th</sup> October 2014  
Kuraray Europe GmbH  
Advanced Materials  
BU Industrial Fibers  
Hideki Onishi

# Overview of Kuraray

- Established June 24, 1926
- Employees 7.550 (consolidated, as of March 31, 2014)
- Net sales 3,0 billion Euro (consolidated, fiscal year 2013)
- Major Businesses Resin, Chemicals, Fibers and textiles, Trading, Others
- Overseas main bases U.S.A., Germany, Belgium, China, Singapore



# World-leading business\*

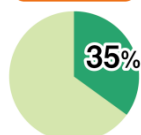
## KURARAY POVAL

(excluding China)

A world-first product commercialized by us



No.1 in the World  
(excluding China)

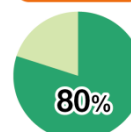


## Optical-use Poval film

A world-first product commercialized by us



No.1 in the World

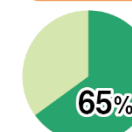


## EVAL (EVOH resin)

A world-first product commercialized by us



No.1 in the World

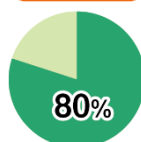


## KURALON KURALON K-II PVA fiber

(excluding China)  
A world-first product commercialized by us



No.1 in the World  
(excluding China)



## Isoprene chemicals

One-of-a-kind products derived from  
synthetic isoprene (MMB, MPD, etc...)



No.1 in the World

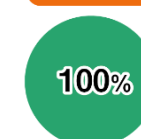
## GENESTAR

Heat-resistant polyamide resin

A world-first product commercialized by us



No.1 in the World

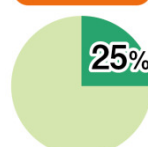


## CLARINO Man-made leather

A world-first product commercialized by us



No.1 in the World



## VECTRAN High-strength polyarylate fiber

A world-first product commercialized by us



No.1 in the World

\*"World-leading businesses" are businesses that have the world's top market share, or are the world's only business in their category(in-house survey).

# Outline

## 1. Introduction of PEI fiber

- What is “PEI resin”?
- Concept of PEI fiber
- PEI fiber products & potential applications

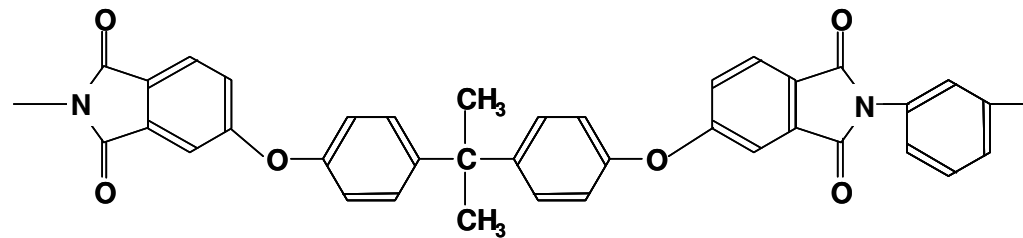
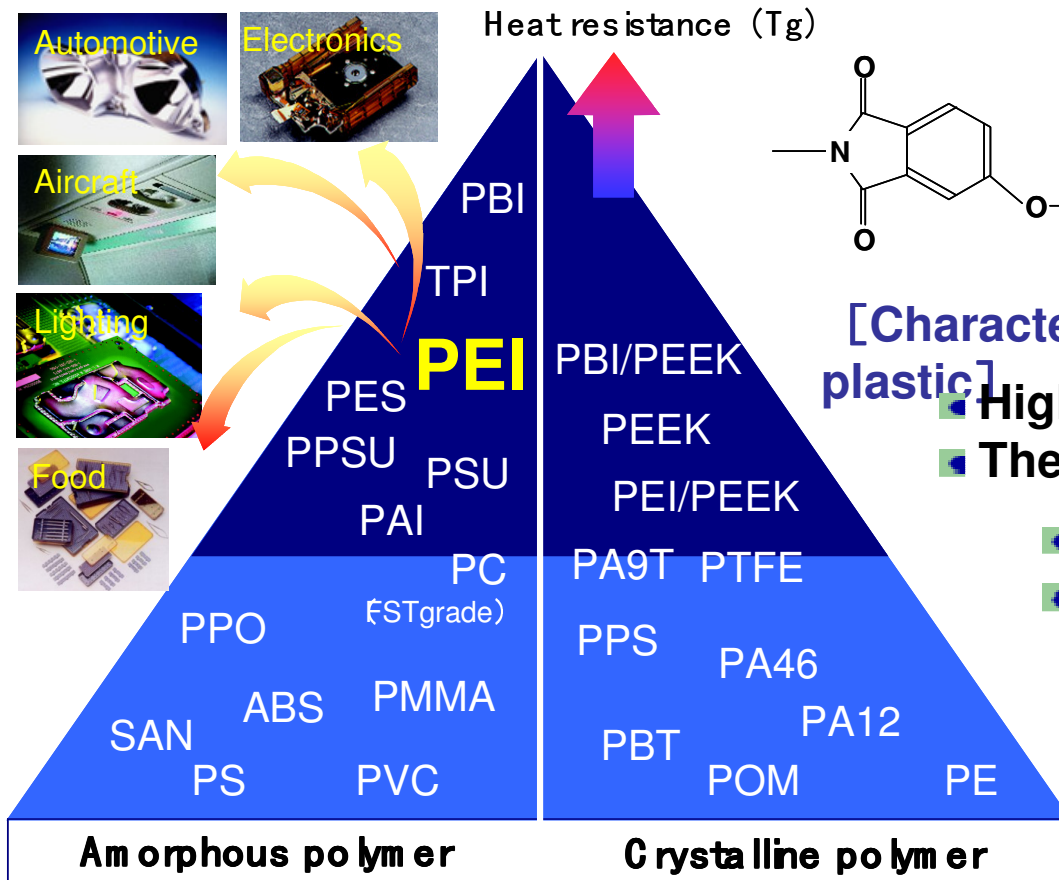
## 2. Composites derived from PEI fiber

- Concept of press molding using PEI fiber
- Characteristic of Method 1
- Characteristic of Method 2

## 3. Summary

# What is “PEI resin”?

**PEI is a high performance amorphous thermoplastic polymer!**



[Characteristics as an engineering plastic]

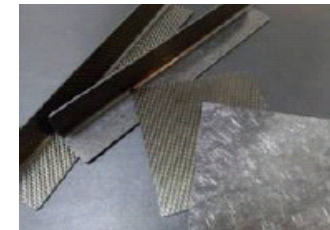
- High heat resistance
- Thermoplastic
- LOI=45
- Low smoke density
- Dimensional stability
- Easy plating
- UV resistance
- Autoclave resistance

# Concept of PEI fiber

As new high heat resistant and flame retardant fiber, PEI fiber has excellent and unique properties, such as fineness, low smoke density during burning and good dyeability. The most important concept of PEI fiber is quite simply “the provision of a secure and safe environment”.

- |                                      |                    |
|--------------------------------------|--------------------|
| ▶ <b>Fineness</b>                    | : 1.7dtex~         |
| ▶ <b>Tenacity</b>                    | : 2.6cN/dtex       |
| ▶ <b>Elongation at break</b>         | : 70%              |
| ▶ <b>Glass transition point (Tg)</b> | : 215°C            |
| ▶ <b>Thermal shrinkage at 180°C</b>  | : <3%              |
| ▶ <b>L.O.I.</b>                      | : 31               |
| ▶ <b>Smoke during burning</b>        | : Very low density |
| ▶ <b>Dyeability</b>                  | : Good             |
| ▶ <b>Others</b>                      | : Thermoplastic    |

\*All data were measured by Kuraray's method. Above indicated values are not guaranteed figure, all specifications are subject to change without notice.





# PEI fiber products & Potential markets

## Potential Markets

### Filament



### Color Fiber



### Staple



### Short cut



### Nonwoven



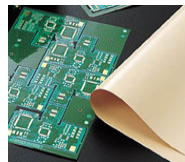
### Spun Yarn



### Transportation



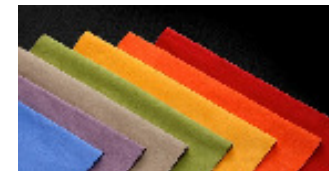
### Safety Life & PPE



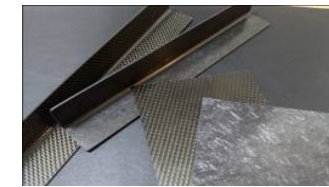
### Electronic & Electronics

### Energy

### Man-made leather



### Composite



### Textile



# Ex.) FR Work Wear

## PEI/FR Rayon/P-aramid

### Feature

- Excellent FR properties
- Good Dyeability
- Softness
- No wrinkle
- Easy to blend other fibers

### Value proposition

- ISO11612/EN531
- NFPA2112 (Thermal Shrinkage)
- Eco-friendly
- Color variation
- Easy care

### Other potential application

- Wall decoration
- Fire blocker for building
- Seats textile for railway and aircraft





# Ex.) Applications for Aircraft

PEI fiber is very useful for FST limited applications

Sheet materials

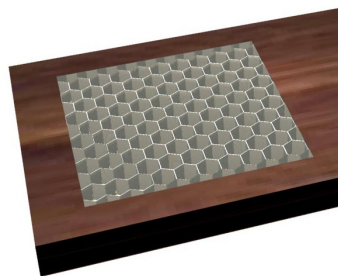
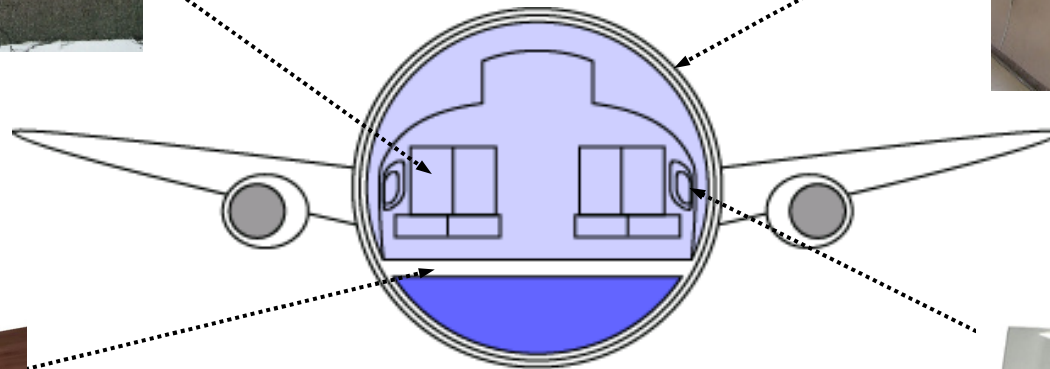
(skin textile, fire blocking layer)



**PEI textile**

Thermal and acoustic  
insulation blanket

**PEI nonwoven**



**PEI paper**

**PEI composite**



Honeycomb core

Window panel

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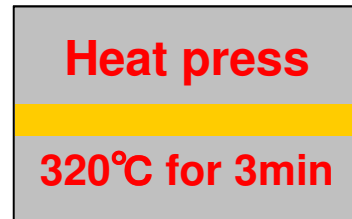
## 3. Summary

# Concept of press molding of PEI fiber

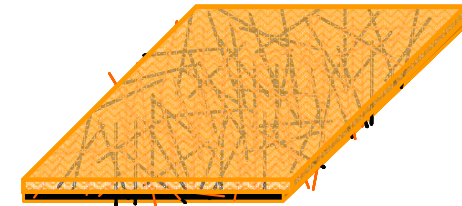
Method with paper technologies

## Method 1 (Hybrid Paper)

PEI/GF or CF Hybrid Paper

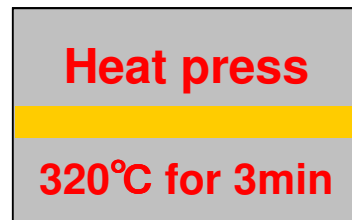
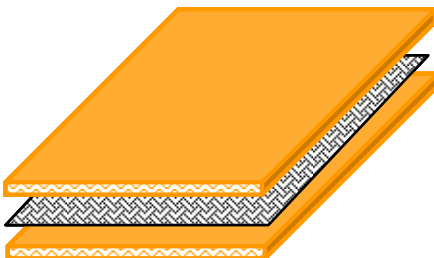


Long fiber composite

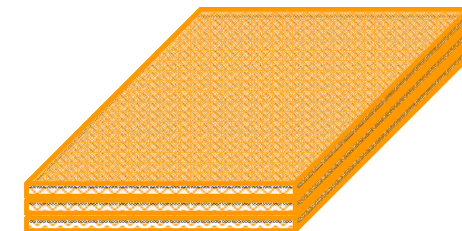


## Method 2 (Paper/Cloth multi ply layer)

Paper/GF or CF Cloth multi ply layer



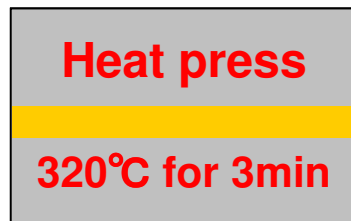
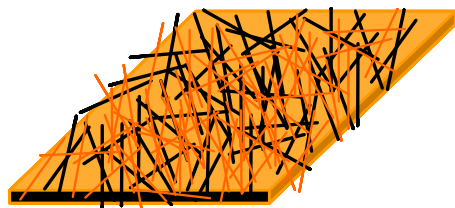
Cloth composite



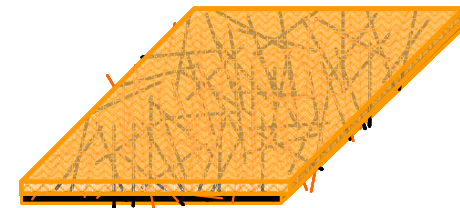
# Characteristics of “Method 1”

## Method 1 (Hybrid Paper)

PEI/GF or CF Hybrid Paper



Long fiber composite



We can ...

(vs. injection molding)

- achieve high content of reinforcement fiber with 60wt%.
- use long cut reinforcement fibers with ~25mm length.
- disperse reinforcement fiber homogeneously.

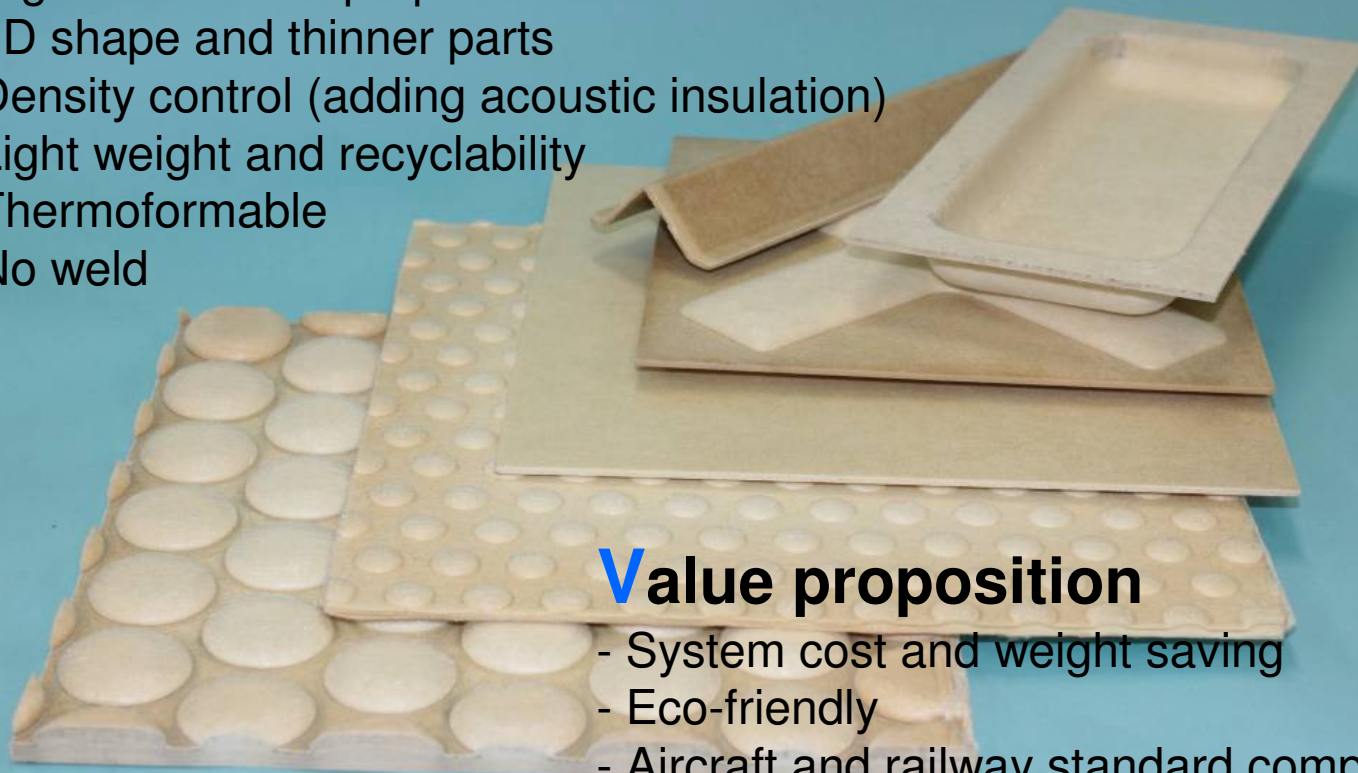
(vs. thermoset composite)

- provide a reduction in manufacturing cost with this materials.

# PEI/GF composite from hybrid paper

## Feature

- Excellent Flame retardant
- High mechanical properties
- 3D shape and thinner parts
- Density control (adding acoustic insulation)
- Light weight and recyclability
- Thermoformable
- No weld



## Value proposition

- System cost and weight saving
- Eco-friendly
- Aircraft and railway standard compliance (FAR, DIN and BS regulations)



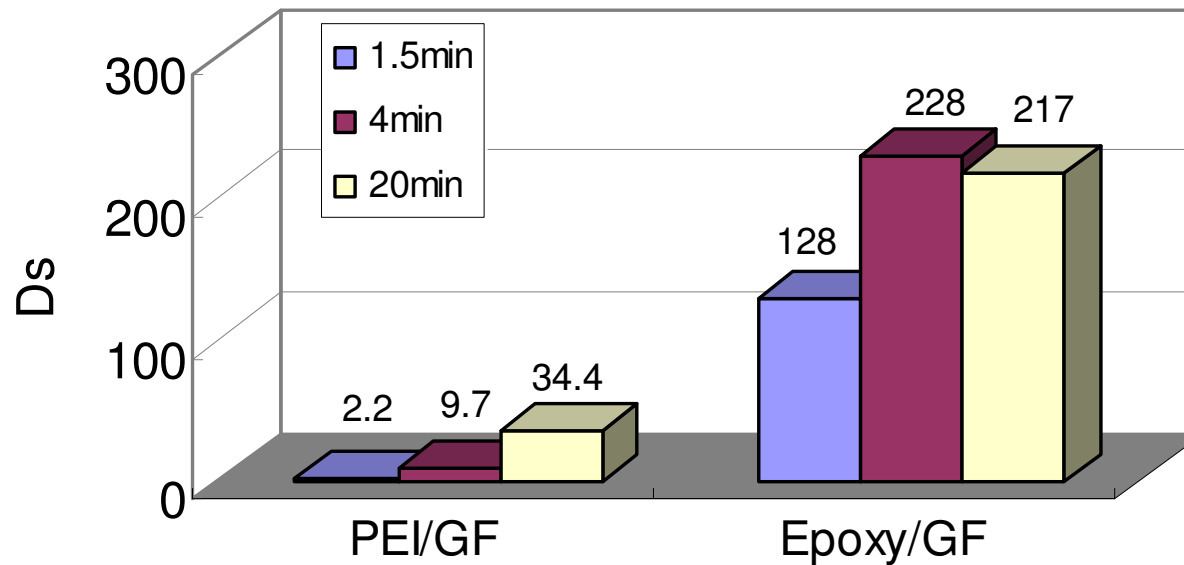
# Typical properties of PEI/GF composite

We can also make PEI/CF composite.

		PEI Composite				
		Injection (GF)	Hybrid Paper (GF)			Hybrid Paper (CF)
Actual density	g/cm <sup>3</sup>	1.55	1.12	1.33	1.64	1.45
Tensile Strength	MPa	130	99	149	159	268
Flexural Strength	MPa	181	110	195	259	360
Flexural Modulus	GPa	5	6	9	12	24
DTUL	°C	200	206	206	206	209
LOI	%	45	45	45	45	45
UL94 (2mm)		V-0	V-0	V-0	V-0	V-0

# FST properties of PEI/GF composite

Smoke density (ASTM E 662)



Toxic gas (BSS7239)

	HF	HCl	HCN	SO <sub>x</sub>	CO	NO <sub>x</sub>
PEI/GF composite	ND	ND	2	<20	80	<2
Epoxy/GF composite	ND	ND	5	<20	180	<20

## Ex.) Window panel

**PEI/GF hybrid paper** (pre-impregnation )

Putting decorating seal



**Consolidation board**

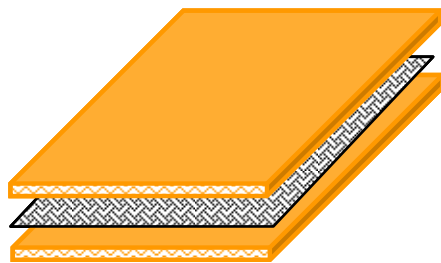
(PEI fiber melted and became matrix polymer of composite)

**Completed product**

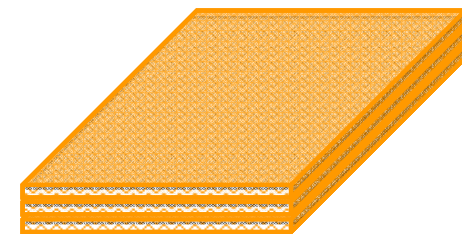
# Characteristics of “Method 2”

## Method 2 (Paper/Cloth multi ply layer)

Paper/GF or CF Cloth multi ply layer



Cloth composite



We can provide to ...

(vs. thremoset composite)

- **get high mechanical properties.**
- **reduce manufacturing cost.**

materials		PEI Composite
		Paper/Cloth Multi ply layer (CF)
Properties		
Actual density	g/cm <sup>3</sup>	1.46
Tensile Strength	MPa	700
Flexural Strength	MPa	760
Flexural Modulus	GPa	40
DTUL	°C	209
UL94 (2mm)		V-0

# PEI/CF Composite

## Potential Application

- Housing for PC and smart phone
- Heat-release board
- Sidewalls, seats... for aircraft, railway and automotive
- Blade for Wind mill

Paper/Cloth multi ply layer

Hybrid Paper



# Outline

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- Concept of press molding using PEI fiber
- Characteristic of Method 1
- Characteristic of Method 2

## 3. Summary

# Summary

1. We have succeeded in manufacturing PEI fiber. This is a new high heat resistance and flame retardant fiber.
2. PEI fiber has several unique properties, such as fine dr, low smoke density and good dyeability. We expect that PEI fiber will be used in various industrial fields such as transportation, Personal Protective equipment and so on.
3. We have developed high performance PEI/GF or CF composites. For this, we propose two methods based on paper technologies; Method 1 is from hybrid paper and Method 2 is from paper/cloth multi ply layer.
4. Especially, the advantage of Method 1 is to achieve high contents of reinforcement fiber with long cut length, leading to high mechanical properties. Both PEI/GF or CF composites also show good FST properties.
5. We hope that our materials help you solve your potential problems.

# Thank you for your kind attention!

We are not just material suppliers!

- We are
- ☑ Your safety guarder
  - ☑ Helping you save cost
  - ☑ Offering total solutions
  - ☑ Environmental protection guarder
  - ☑ Your industrial partner



Kuraray Europe GmbH

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BU Industrial Fibers

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