

# Fluoropolymer / carbon fiber composite

(under development)

PRODUCT  
INFORMATION

Daikin's new developed "Fluoropolymer / carbon fiber composite" is a type of CFRTP (Carbon Fiber Reinforced Thermo Plastic) with excellent chemical resistance.

It is also expected to be used in various applications that require structural strength (mechanical characteristics), light weight, impact resistance, anti-smudge, water and oil repellency, slidability, flame resistance, and heat resistance.

## Background of development

Daikin has been working on the development of a composite material with fluoropolymer and carbon fiber. This time, we succeeded in overcoming the challenge to improve mechanical properties without impairing the excellent features of fluoropolymer.

This new composite can be contributed to solve the following issues.

- Improve the mechanical strength of fluoropolymers
- Replace from the metal parts for the weight reduction
- Improve the characteristics of conventional Carbon Fiber Reinforced thermo setting Plastics (CFRP) such as impact resistance, anti-smudge, water and oil repellency, slidability, and flame resistance.
- Prevent the fluoro coating film falling off from the base material

## Solution

- Downsizing and weight reduction by replacing from the metal parts (specific strength, toughness, heat resistance, low coefficient of linear expansion)
- Improve the properties by replacing from the thermosetting CFRP (chemical resistance, slidability, impact resistance, flame retardancy, anti-smudge)
- Improve moldability by chopped fiber (formability, reworkability)

## Features

### 1. Supporting higher Vf\* designs

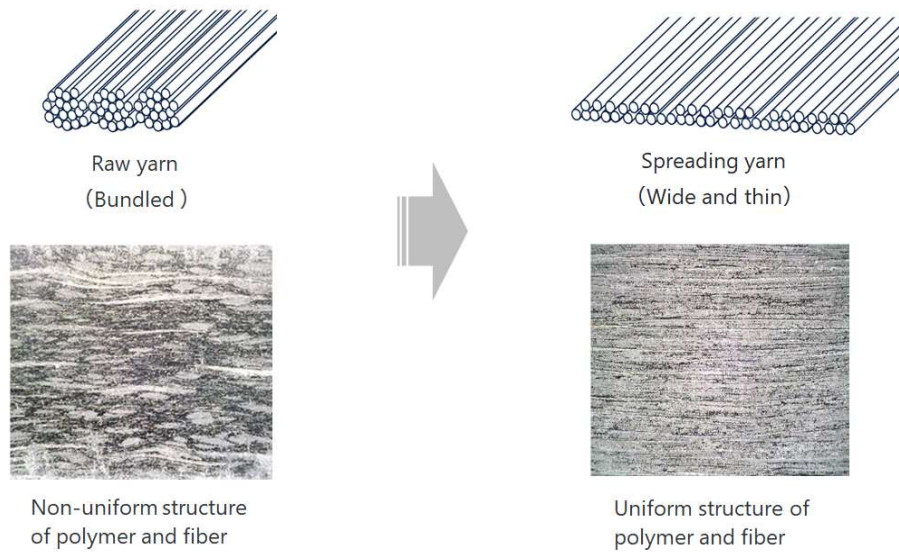
Due to the advanced carbon fiber spreading technology, it has excellent resin impregnation properties, and a dense laminated structure can be obtained even after molding.

It is possible to fabricate high impregnation, and higher Vf (over 50%). Therefore, higher strength can be expressed.

The uniform structure composite is resistant to delamination and improves the strength. (Fig.1)

Note \*Vf: Fiber volume content

**Fig.1 Carbon-fiber spreading technology**



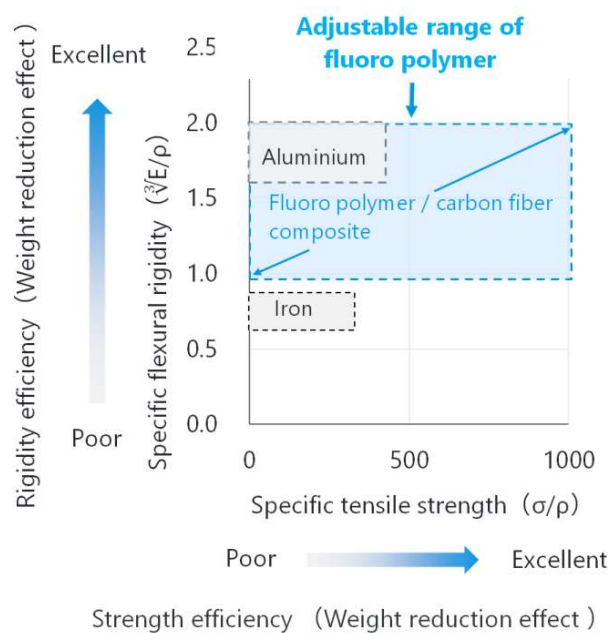
**2. Contributing for weight reduction by replacement from metal parts**

The composite of fluoropolymer and carbon fiber can be contributed to high specific tensile strength and specific flexural rigidity. With these advantages, it is possible to reduce the weight with the same strength compared with iron or aluminum.

In case of the chopped sheet, it is expected to 33% weight reduction effect compared with iron.

Physical property such as specific tensile strength is just the example, then it can be further improved by carbon fiber content and fiber orientation.

**Fig.2 Comparison of weight reduction effect**



**Table.1 Comparison of mechanical properties**

Fiber orientation	Fluoropolymer		Iron	Al**
	UD sheet	Chopped sheet		
	Orthogonal***	Random		
Vf (%)	23	23	—	—
Tensile strength (MPa)	268	133	340	315
Tension modulus (Gpa)	16	15	210	70
Elongation at break (%)	4.0	2.8		
Bending strength (MPa)	167	129	—	—
Flexural modulus (Gpa)	32	11	—	—
Izod impact (kJ/m <sup>2</sup> )	59	65	—	—
Tg (°C)	90	90	—	—
Continuous temperature (°C)	260	260	—	—
Specific tensile strength ( $\sigma/\rho$ )	130	65	44	117
Specific tensile rigidity ( $E/\rho$ )	8	7	27	26
Specific bending strength ( $\sqrt{\sigma/\rho}$ )	81	63	2	6
Specific flexural rigidity ( $\sqrt[3]{E/\rho}$ )	1.5	1.1	0.8	1.5
<b>Weight reduction effect (against Iron)</b>	<b>67%</b>	<b>33%</b>	—	63%

Note\*\* Aluminium

Note\*\*\* Laminated UD prepreg in the orthogonal direction

### 3. Excellent moldability and fluidity

Chopped sheets are randomly oriented prepregs made with carbon fiber shredded (chopped) in the length to keep high strength. Since chopped fibers flow with the melted polymer and filling up to the corner of mold, it is possible to suppress uneven strength of each part of the molded product.

### 4. Excellent acid resistance and alkaline resistance

### 5. Excellent impact resistance

Since the fracture toughness of fluoropolymer is kept even its composite with carbon fiber, it is harder to crack and has excellent impact resistance compared with conventional CFRP.

### 6. Excellent heat resistance

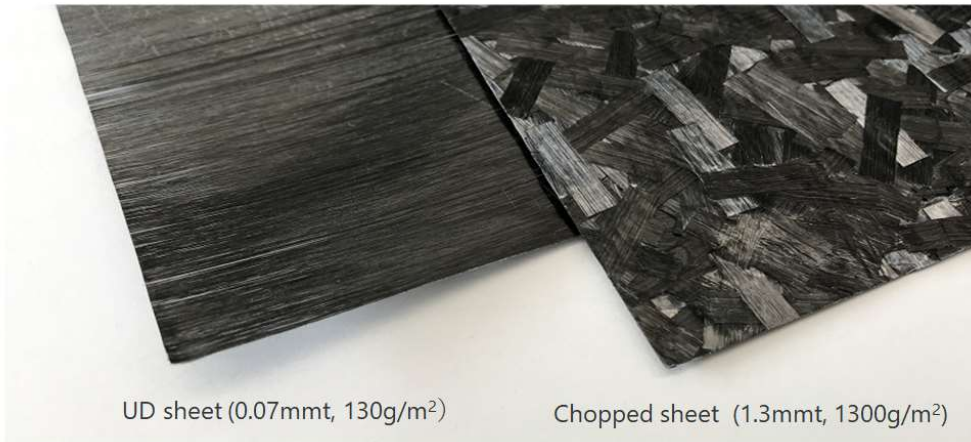
### 7. Excellent slipperiness due to the low friction surface

### 8. Excellent water and oil repellency, mud adhesion prevention and removal

### 9. Excellent frame retardancy

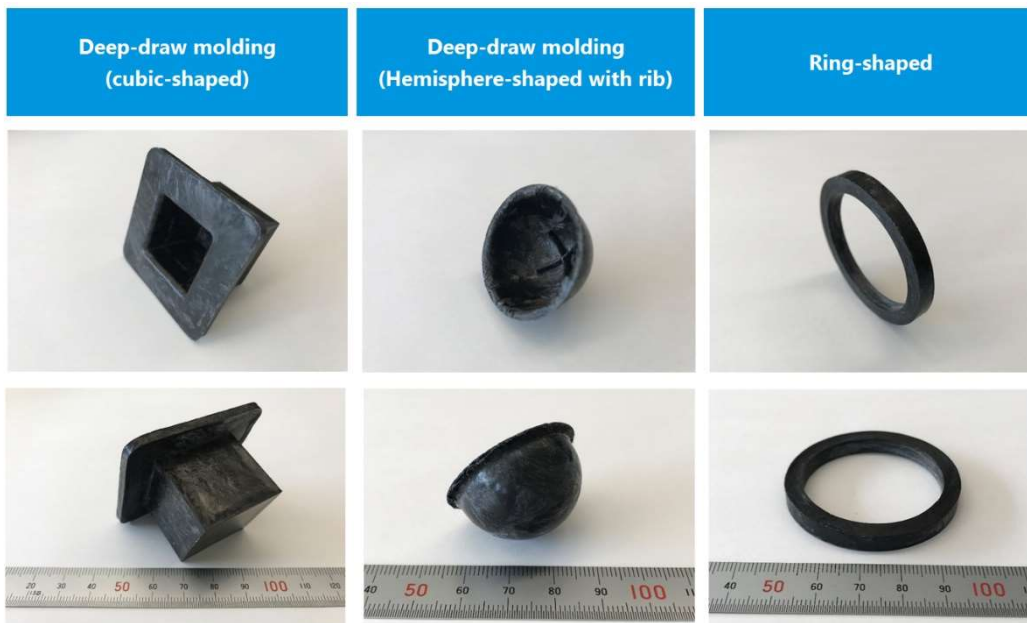
### Assortment

The appearance of two types of composite sheets with different fiber orientations.



### Examples of molding

Since chopped fiber is highly fluid, it can be molded into various shapes.



### Expected industries and application

- Robots, drones, aircraft, automobiles, oil and gas, marine structures that require weight reduction
- Semiconductors, life sciences, and food applications that require cleanliness
- Large structures that require extensive maintenance (offshore wind power generation, etc.)
- Alternative material for metal parts coated with fluoro paint

Please let us know your opinions and impressions about this product.

Note\*\*\*\* All the data shown in this report are not guarantee

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