

<FRP-(3)>

FRP (Glass Fiber) 가 1940 .
가 FRP FRP
가
1939
93 가
Vetrotex 가 50 50 , 92 6 2 5000
60%, 30% 10%
73 (1)가
가 ,
2 5000 Roving · Roving Clode · Chopped
Strand
Vetrotex 92 6 800 2 5000
5000 가 70%
3 5000 2 , 1 5000
1 , 1 , 1 5000
94 40%, 40%, 20%
92 2 93 1 5000
94 1

PAN					
	1991	1992	1993	1994	1995
	2,280	2,550	2,700	2,800	3,100
	1,260	1,300	1,425	1,575	1,700
	1,400	1,400	1,500	1,600	1,700
	1,350	1,400	1,450	1,550	1,650
	6,290	6,650	7,075	7,525	8,150

(FRP)	
FRP(PMC)	· GFRP(FRP,GRP)
	·
	· CFRP (GRFRP)
	· ARFRP(KFRP)
	· (BFRP)
FRM(MMC)	· (CFRM)
	· (AFRM)
	· (SFRM)
	· (BFRM)
(FRC)	
(FRCon)	

Material	Quantity	Unit	Material	Quantity	Unit
Yarn	1500	KG	Chopped Strand	1500	KG
Chopped Strand	1800	KG	Yarn	2000	KG

The graph shows the relationship between Modulus of Elasticity (E) and Strain (ϵ) for two materials. The y-axis represents E in MPa, and the x-axis represents ϵ in percent. Material 1 (stiffer) has a higher slope, while Material 2 (less stiff) has a lower slope. A horizontal dashed line at $E = 2000$ MPa intersects both lines, with vertical dashed lines dropped to the x-axis at approximately 0.8% and 2.5%.

Material	Strain (ϵ in %)	Modulus of Elasticity (E in MPa)
Material 1 (Stiffer)	0	0
Material 1 (Stiffer)	0.8	2000
Material 1 (Stiffer)	1.2	3000
Material 2 (Less Stiff)	0	0
Material 2 (Less Stiff)	2.5	2000
Material 2 (Less Stiff)	3.2	2600

Bar chart showing the number of individuals (x 10⁶ cm) for different species (F, R, P, M) across various categories (C, S, F, /). The y-axis ranges from 0 to 14. A horizontal line is drawn at 4. An arrow points to the first bar (C) with the number 4. The legend indicates: F (black), R (white), P (black), M (grey).

Category	F (Black)	R (White)	P (Black)	M (Grey)
C	0	2.2	0	0
S	0	1.8	0	0
F	0	2.2	0	0
/	0	2.4	0	0
C	6.3	0	0	0
S	6.3	0	0	0
F	8.0	0	0	0
/	13.2	0	0	0
C	10.2	0	0	0
F	0	2.5	0	0
/	0	2.3	0	0
C	0	2.1	0	0
S	0	5.2	0	0
F	0	6.0	0	0

가

E-

, C-

S-

CFRP

E-

E- S- ACM (SiO2),
 (-SiO4)n

(Carbon Fiber) 가 ,
 가 92 500 가 90%

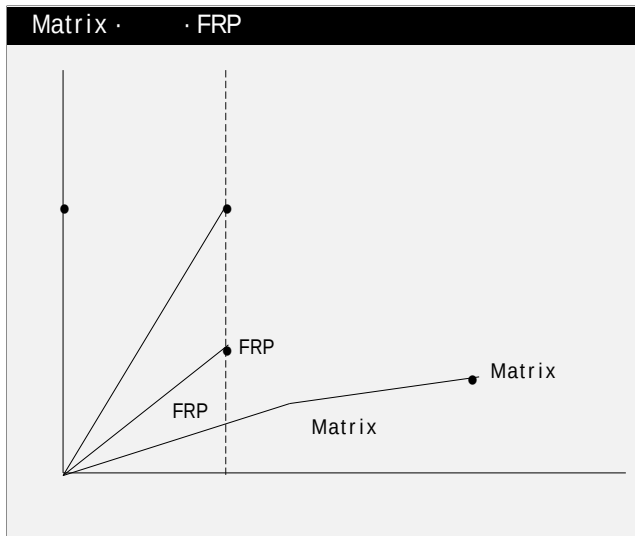
Rayon · PAN · Pitch 가
 (PCF) · (HPCF) · (HTCF) ·
 (HMCF) · (UHTCF) 500 (UHMCF)

91
 가 KG 3 GF 10

PAN					
		()		(m ² /)	
	Toray	2250		636	· -94 · 70% - · 35% - 가 · () 70% · Toray composit America() 92
	東邦Rayon	2020		400	· 東邦 50% - · Akzo()
		500		400	· () 91 · () 91 · 90 1- · BPAC
	住化	-		-	· ,
	新旭化成CF	450		140()	-
		230		-	· BPAC
	()	60		-	· 日幾裝
		100		-	· RK
	Amoco	1000		-	· Toray
	Toray composit America	-	-	-	· 92 Toray가
		400		-	· 91
		-	-	-	· 90 ()
		365		-	· Akzo()
	BPAC	40		-	-
		1715	住化	-	-
	Zoltek	100		-	-
	Avoco V	20		-	-
	FMI	5		-	-
	Soficar()	360	Toray	-	· Toray가 70%
	Akzo()	500	東邦	-	-
	Contaulds Grafil()	-	-	-	· 91
					· 91 ()
	Sigri()	100		-	-
	R&K Carbon()	100		-	-

90%

가



PAN		(: M/T)			
		1984	1987	1989	1991
	Toray	1,260	1,500	1,500	2,250
	Tosoh Rayon	1,020	1,380	1,420	2,020
	Mitsubishi Rayon	120	120	360	500
	Sghin-Asahikasei	180	300	360	450
	Fiber				
		2,580	3,300	3,640	5,220
	Hercules	840	1,050	1,050	1,750
	Celanease CF	275	450	450	1,350
	Amoco	360	360	450	1,000
	Akzo	300	360	450	365
	BPAC	125	125	155	40
	Courtaulds Grafil	150	150	300	320
	Zoltek	115	115	115	100
	Avco	-	-	-	20
		2,165	3,610	2,970	4,955
	Coutaulds Grafil()	350	350	350	-
	R&K Carbon()	20	50	150	100
	Akzo()	-	360	500	500
	Sigri()	20	30	220	100
	Soficar()	-	300	300	360
	()	-	100	100	100
		390	1,190	1,620	1,160
	Afikim Carbon()	-	100	100	100
	Taiwan plastic()	-	100	100	200
	()	-	150	-	-
	()	-	-	60	60
		-	-	-	50
		-	350	1,260	410
		5,135	7,450	8,490	11,745

90
1214 91 22.1% 가
1473 , 92 1683

90 9 91 4 92
13.4

가

90 87
256 92 91 4.5%
가 276 228 ,

48
92 65 가 41 ,
24
92 가
91 14.2% 41

10%

80
가

85

PAN(Polycarylo-nitrile)
3130
1500 47.9%, 550 17.6%,
680 21.7%, 400
12.8%

50%,
83%, 36% 45%
80
87 4370 39.6%, 89
6310 44.4%

91 90
26.5% 2280
90 12% 가
1400 90 9.6% 가
1260

PAN 93
92 6.4% 가 7000 , 94
6.4% 가 7525 가

Hercules 1750 , Celanese CF 1350 5000
 Toray 2250 , Tosoh Rayon 2000 Mitsubishi Rayon 500 5200 ,
 PAK Carbon 100 , AKZO 500 1100 1 2000
 93 20% 가
 94
 90~92
 가 10%
 가

Pitch가 (GPCF)
 (ACF) 가
 (Precursor) Rayon PAN
 Pitch

FRP	(: M/T, %)		
	1990	1995	2000
G F R P	75,000	150,000	255,000
C F R P	597	1,500	3,000
K F R P	200	600	1,500
	75,797	152,100	259,500

	(: 1000M/T)							
	1988	1989	1990	1991	1988	1989	1990	1991
	1,469	1,467	1,496	1,359	289	307	321	300
	624	600	559	492	238	258	263	252
	211	220	212	195	153	139	161	166
	1,391	1,286	1,413	1,234	357	375	385	385
	636	662	796	796	497	482	484	474
					127	122	142	142

Rayon 가 , PAN (PAN)
 Pitch PAN
 Pitch 가
 가
 (Mesophase) Pitch
 가 PAN
 가
 (GP:General Perform-ance)
 (HP:High Tensile Strength) (HM:High Modulus)

(Wholly Aromatic Polyamide) (Aramid)
 Meta Oriented Para Oriented (Kevlar)

400
 Kevlar29 KeVI-ar49가 KeVI-ar29 가
 Velt
 KeVlar49 (Stiffness)

가 (Bcl3) (H2) 가

100

가

70 가 DSM 가

(SiC) 1970 AVCO (Al2O3)

1970 Dupont 가

GFRP/CFRP

GFRP 1940

GFRP GFRP 가

GFRP 가

GFRP , 95 15

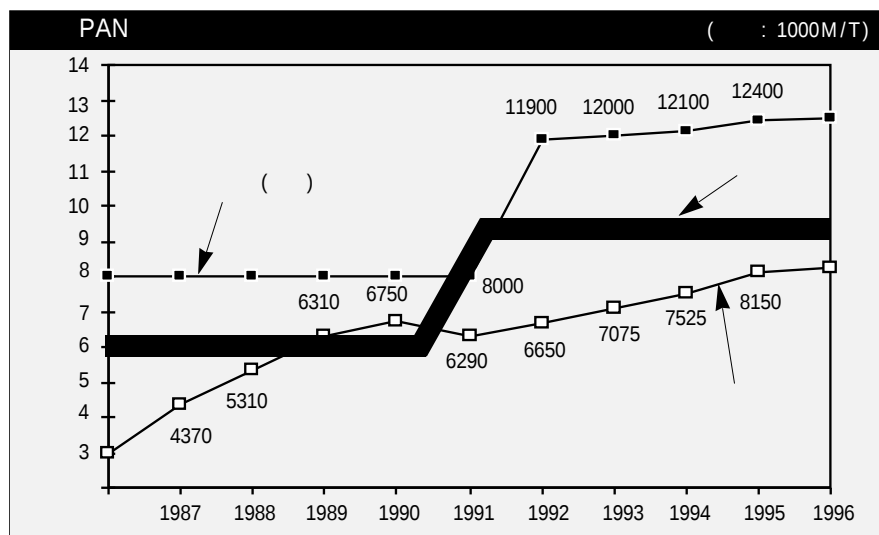
GFRP , 90 7 5000 , 92 10

GFRP

	FRP	ACM
	Prepreg	Hybrid
	ACM가	
Matrix		340
	120	560kg/mm ²

85 ~ 90
20%

10%



FRP

Hand Lay UP

Spray UP FRP 30%

가 GF

93 가 GFRP

GFRP 85 205 3000 2000 420 가

50% 가

GFRP 1950 , 60 80% , 70

93 가 8% 4.0% 4.2% 10% 7.2%, 가

GFRP CFRP가 1950

CFRP 1 GFRP 2

CFRP 가 CF

CFRP

CFRP 85 240 90 600 , 92 800 95

1500 80%

90 5500 92 6700 22%가 가 CFRP 25%

CFRP 가 CF/EP CF/PI 가 CFRP

CF/EP CF/PI

CFRP 가 , KAL ADD

KIST CFRP 90%

CFRP CF CF 가

FRP 가

GFRP

(ACM) Prepreg ,

Hyb-rid ACM가 가

GFRP 가 KFRP가 , KFRP 90 200 95 가

600 KFRP FRP (FRP)

(ArFRP),