VALUE CHAIN OF CARBON FIBERS

Grafil Inc.

Issues associated

with

production, conversion, and supply

of

PAN carbon fibers

into

high volume applications.

Presented by: Martin Kokoshka

CARBON FIBERS AND ADVANCED MATERIALS DIVISION

Mitsubishi Rayon

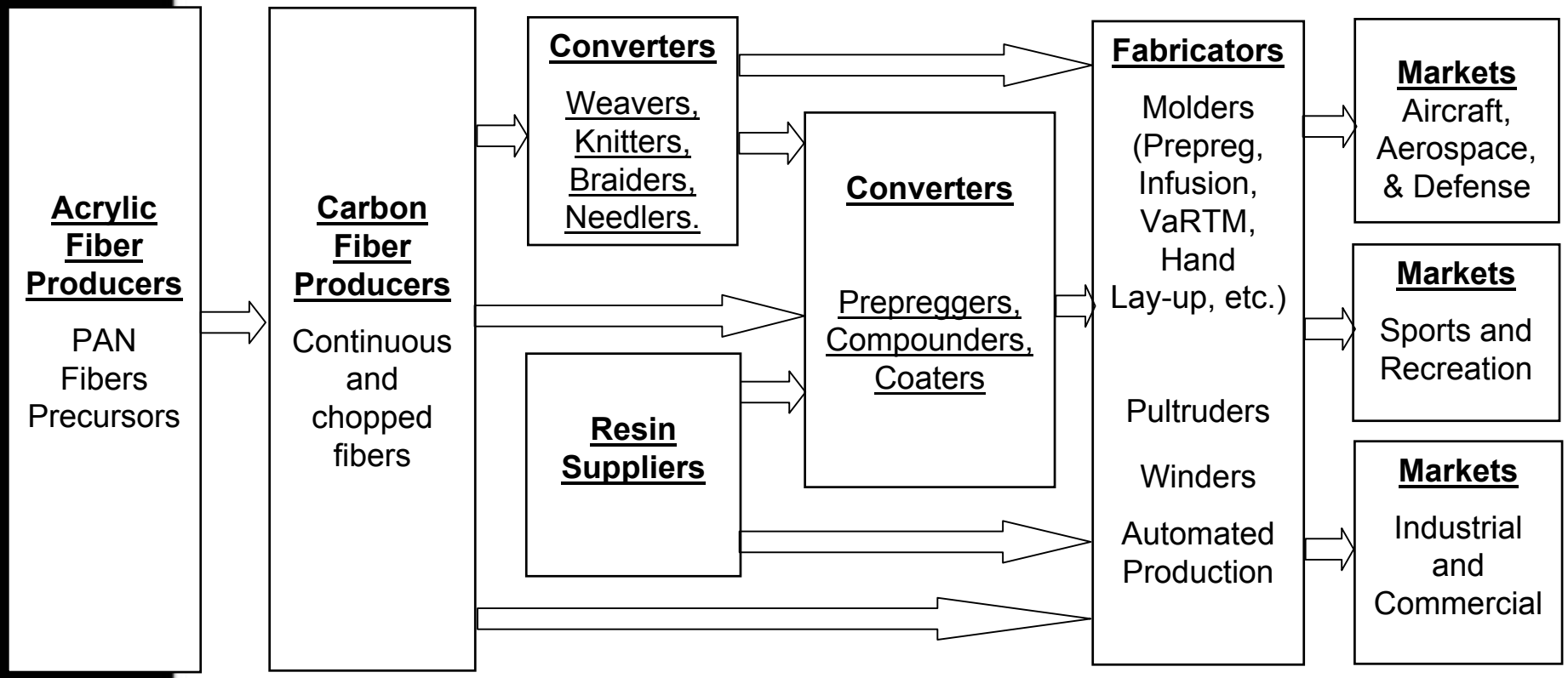
Mitsubishi Rayon Co. Ltd.
PAN Precursors,
Carbon Fibers,
Resins,
Prepregs
(www.mrc.co.jp)

Grafil Inc.
Carbon Fibers
(www.grafil.com)

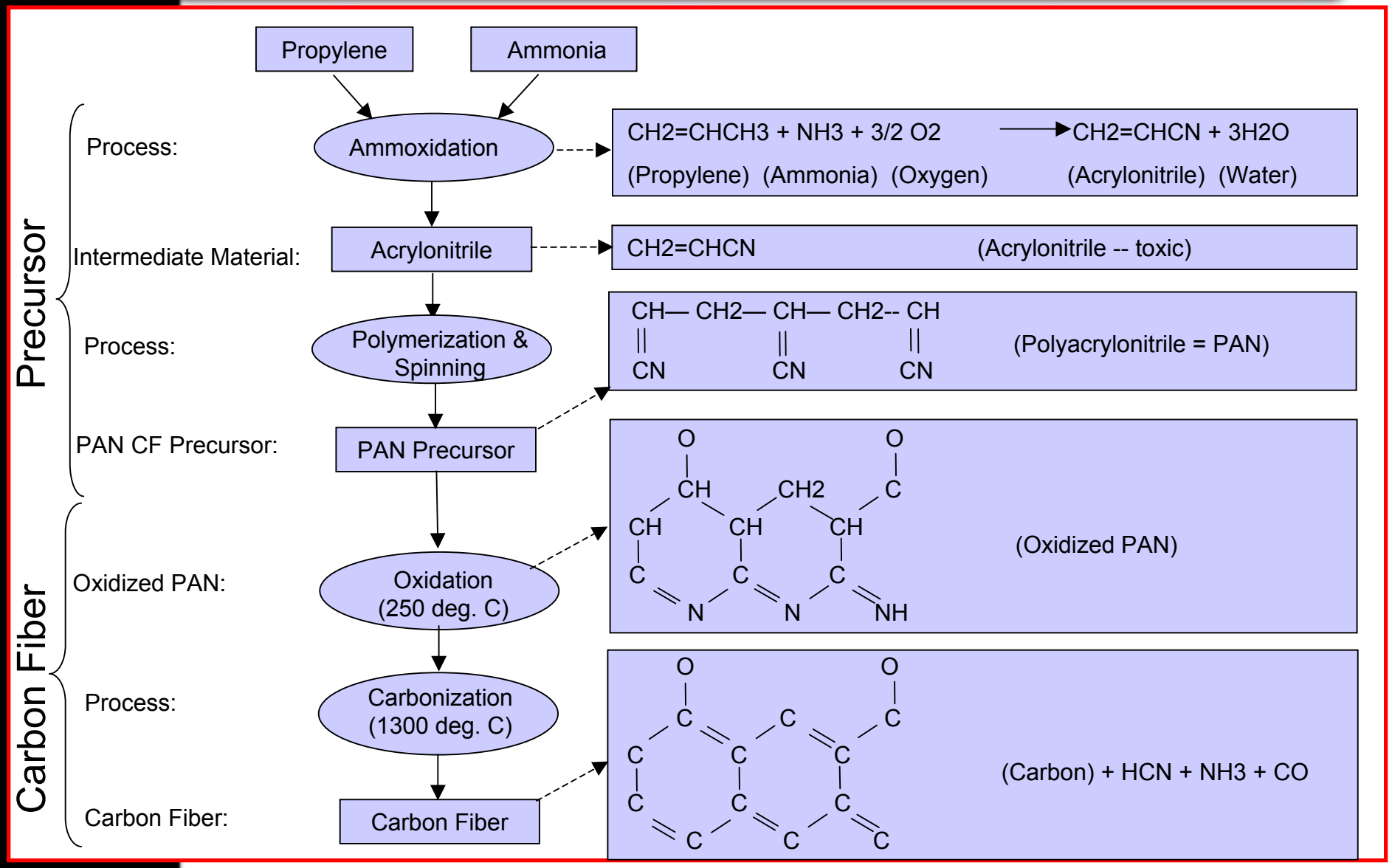
Newport Adhesives and Composites
Prepregs, Adhesives,
and Resins
(www.newportad.com)

CARBON FIBER SUPPLY CHAIN

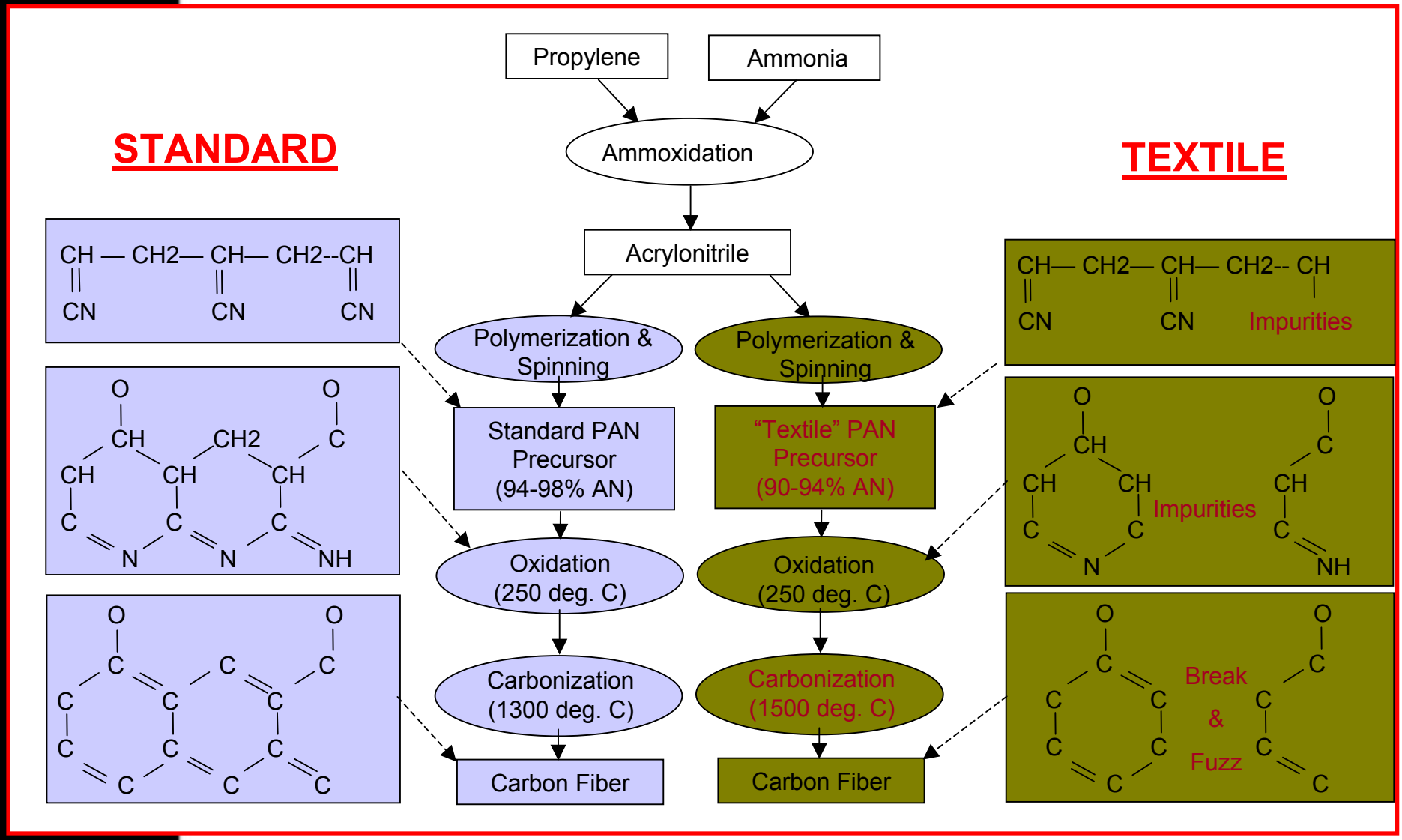
…series of **CUSTOMER-SUPPLIER** relationships



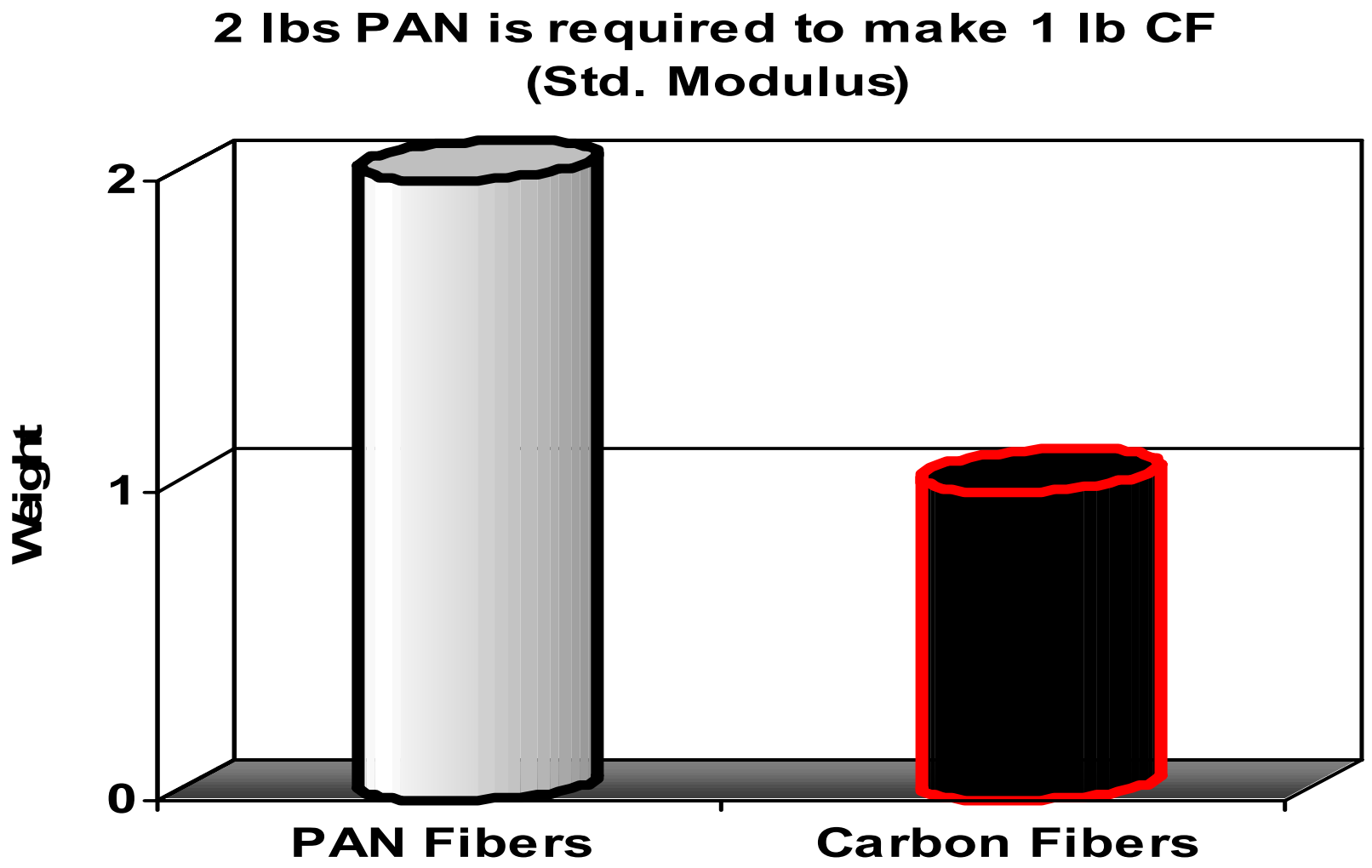
MANUFACTURING PROCESS



STANDARD vs. TEXTILE



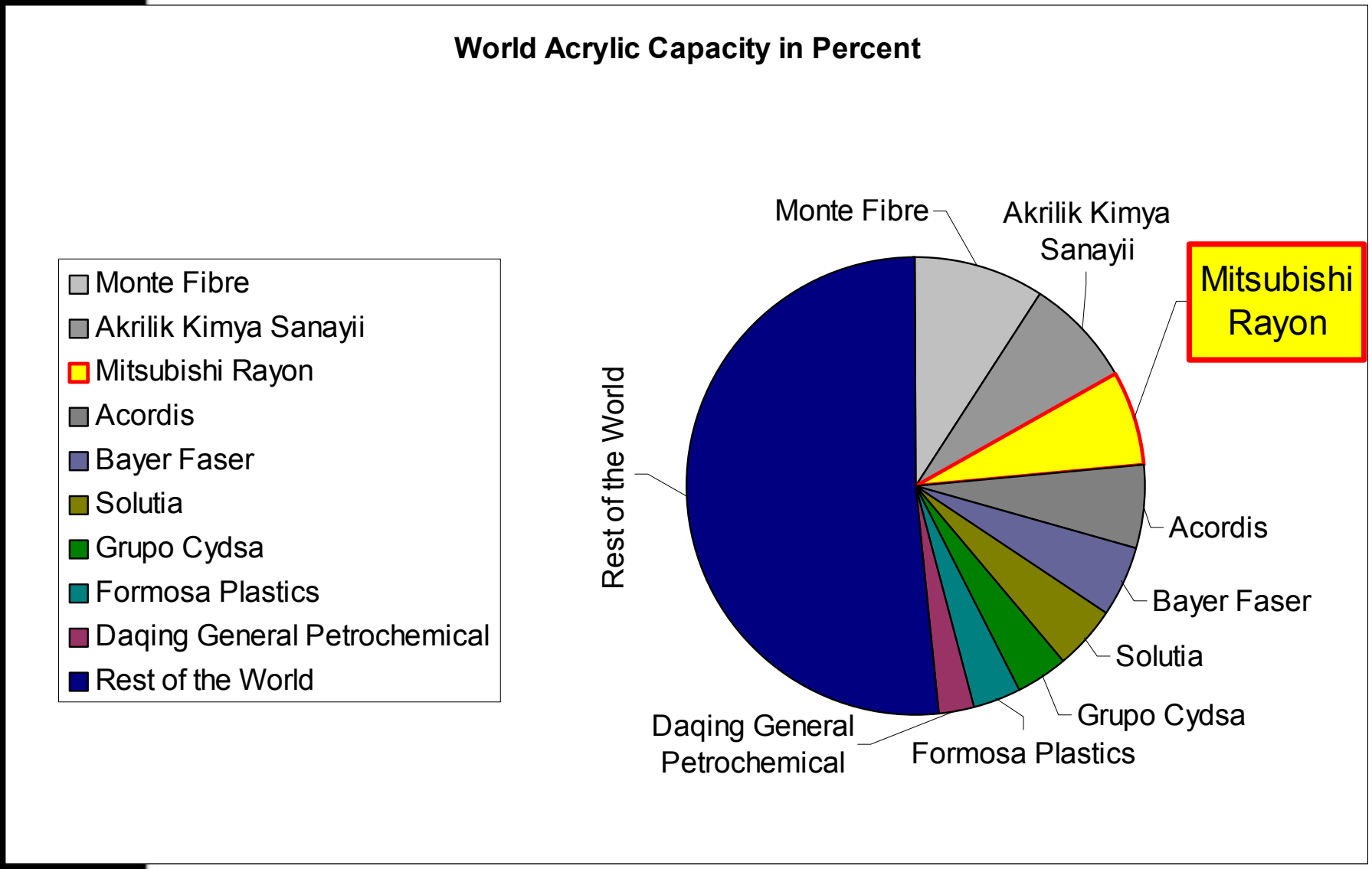
COST DRIVE: PAN



ACRYLIC AND PAN PLANT

Mitsubishi Rayon

WORLD ACRYLIC CAPACITY



PAN-CF CONVERSION PLANT

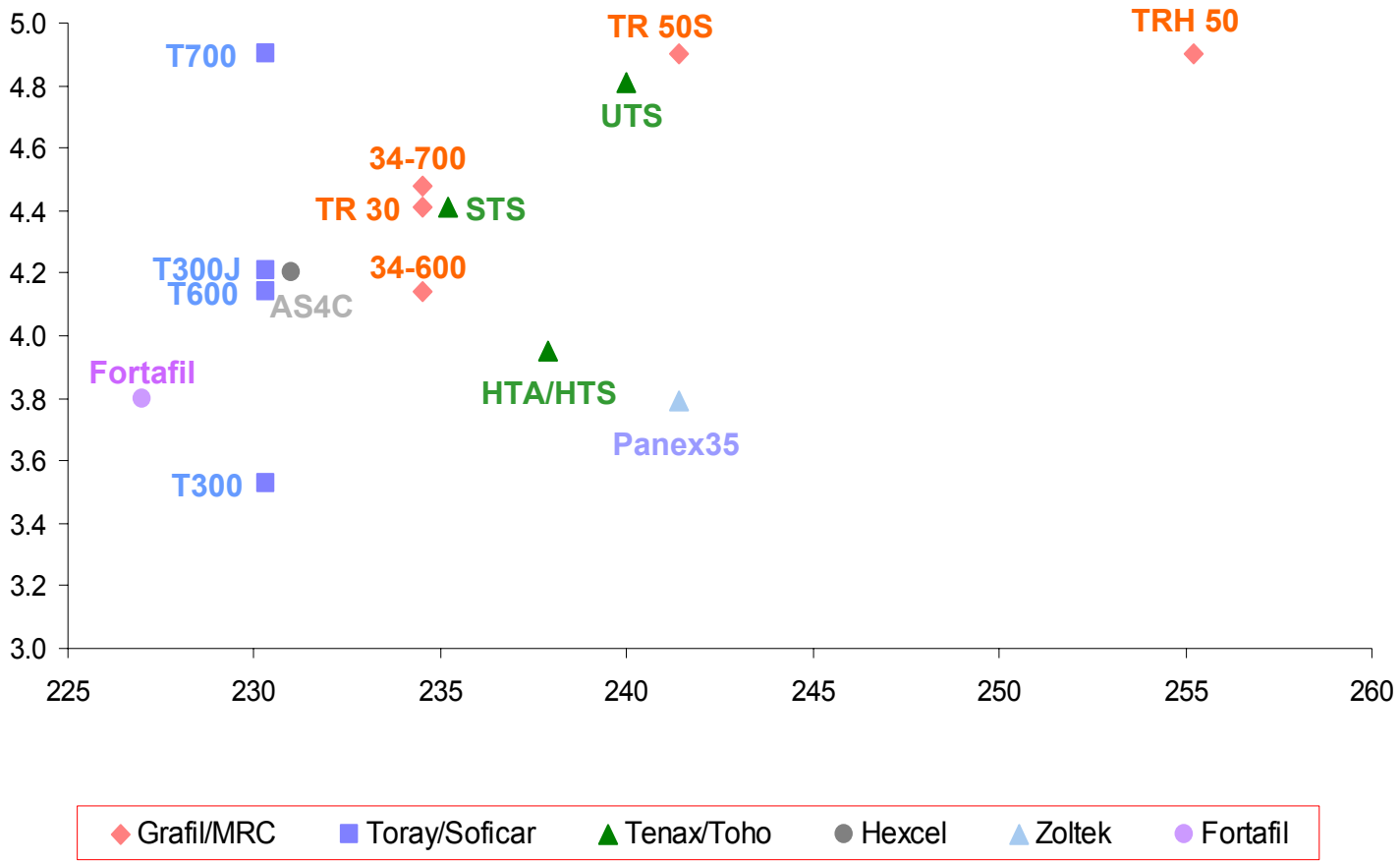
WORLD OVEN CAPACITIES

(est.: millions of lbs), 1996 – 2002

		1996	1997	1998	1999	2000	2001	2002
Standard Tow	*Toray (TOTAL)*	6.4	6.4	10.4	16.1	16.1	16.1	16.1
	Japan	6.4	6.4	10.4	10.4	10.4	10.4	10.4
	France (Soficar)				1.8	1.8	1.8	1.8
	USA				4.0	4.0	4.0	4.0
	Toho (TOTAL)	8.2	8.2	11.7	12.3	12.3	12.3	12.3
	Japan	6.4	6.4	7.7	8.2	8.2	8.2	8.2
	Germany (Tenax)	1.8	1.8	4.0	4.2	4.2	4.2	4.2
	MRC (TOTAL)	4.2	4.2	7.5	7.5	7.5	7.5	10.4
	Japan (Pyrofil)	2.6	2.6	5.9	5.9	5.9	5.9	7.0
	USA (Grafil)	1.5	1.5	1.5	1.5	1.5	1.5	3.3
	Hexcel	3.7	4.4	4.4	4.4	4.4	4.4	4.4
	Cytec	3.0	4.0	4.0	4.0	4.0	4.2	4.2
	Formosa	0.6	1.7	1.7	3.9	3.9	3.9	3.9
	Others	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Sub Total	26.1	28.9	39.7	48.3	48.3	48.5	51.4
"Textile" Tow	*Fortafil*	2.5	4.6	7.7	7.7	7.7	7.7	7.7
	Zoltek	1.0	2.0	3.0	4.0	4.0	4.0	4.0
	Aldila	0.0	1.3	2.2	2.2	2.2	2.2	2.2
	SGL	1.7	2.0	4.2	4.2	4.2	4.2	4.2
	Sub Total	5.2	9.9	17.1	18.1	18.1	18.1	18.1
Grand Total		*31.3*	*38.8*	*56.8*	*66.3*	*66.3*	*66.6*	*69.4*

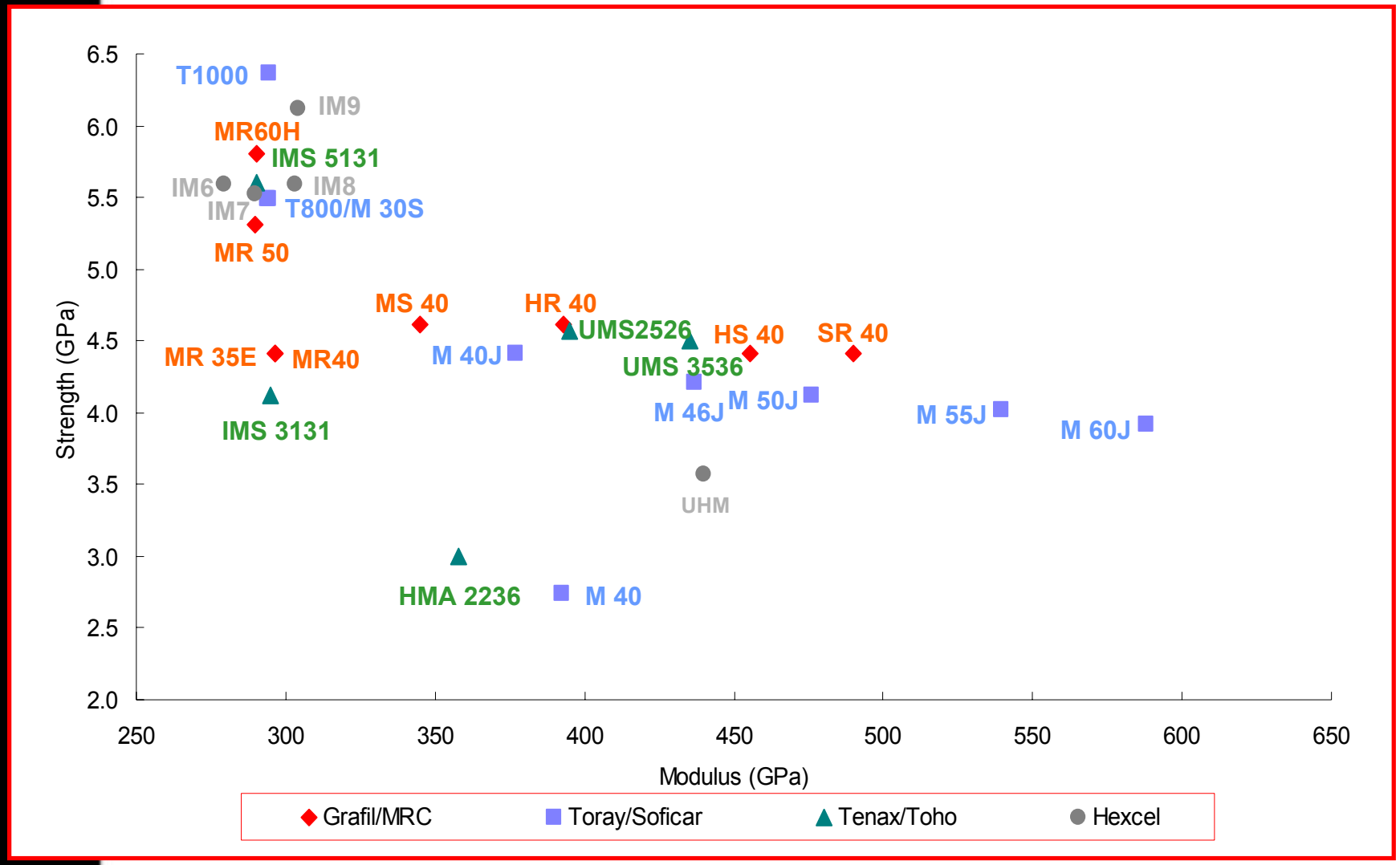
NOMINAL PROPERTIES

(Std. Modulus: 225-260 GPa)

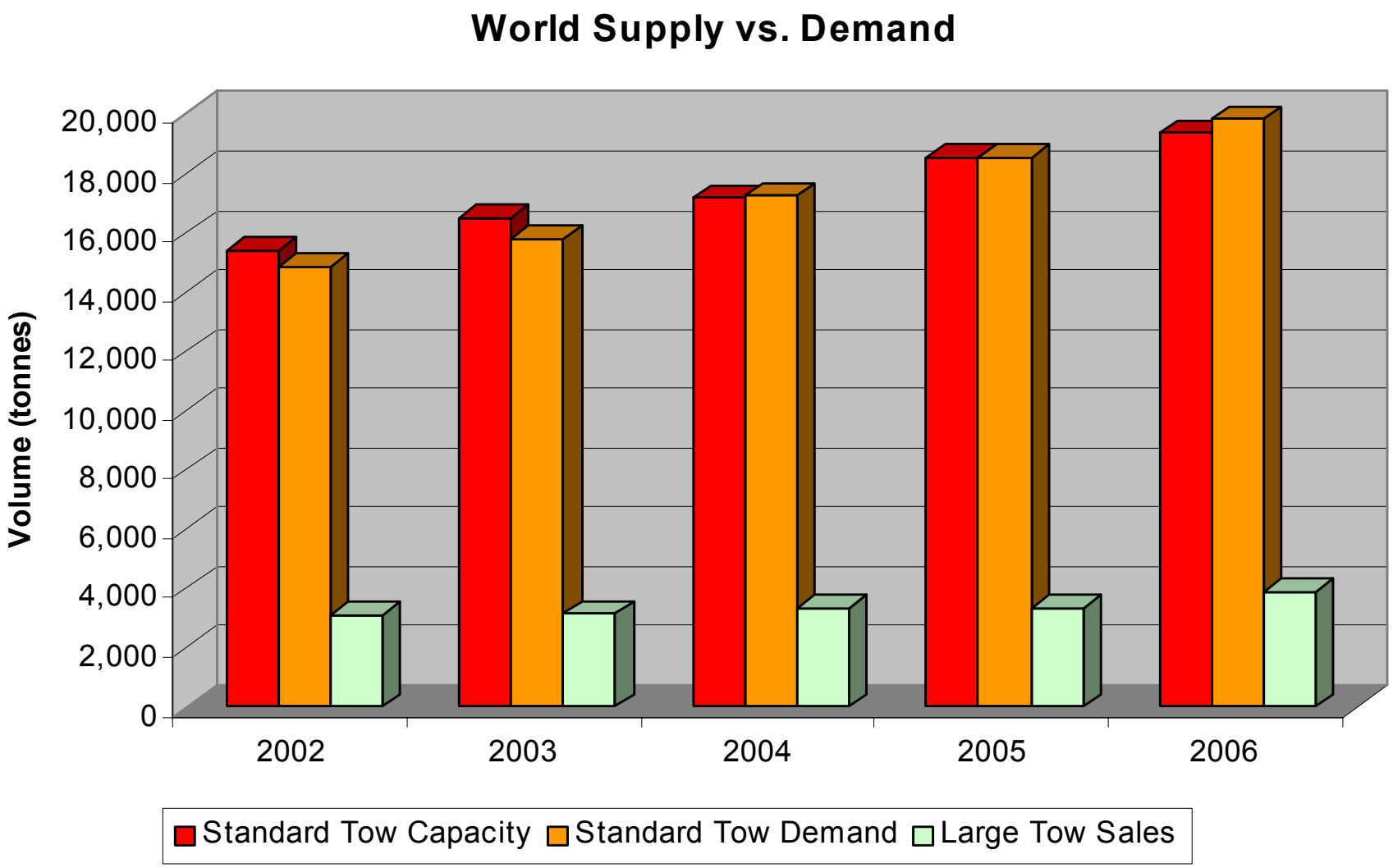


NOMINAL PROPERTIES

(Intermediate and High Modulus: 250-650 GPa)



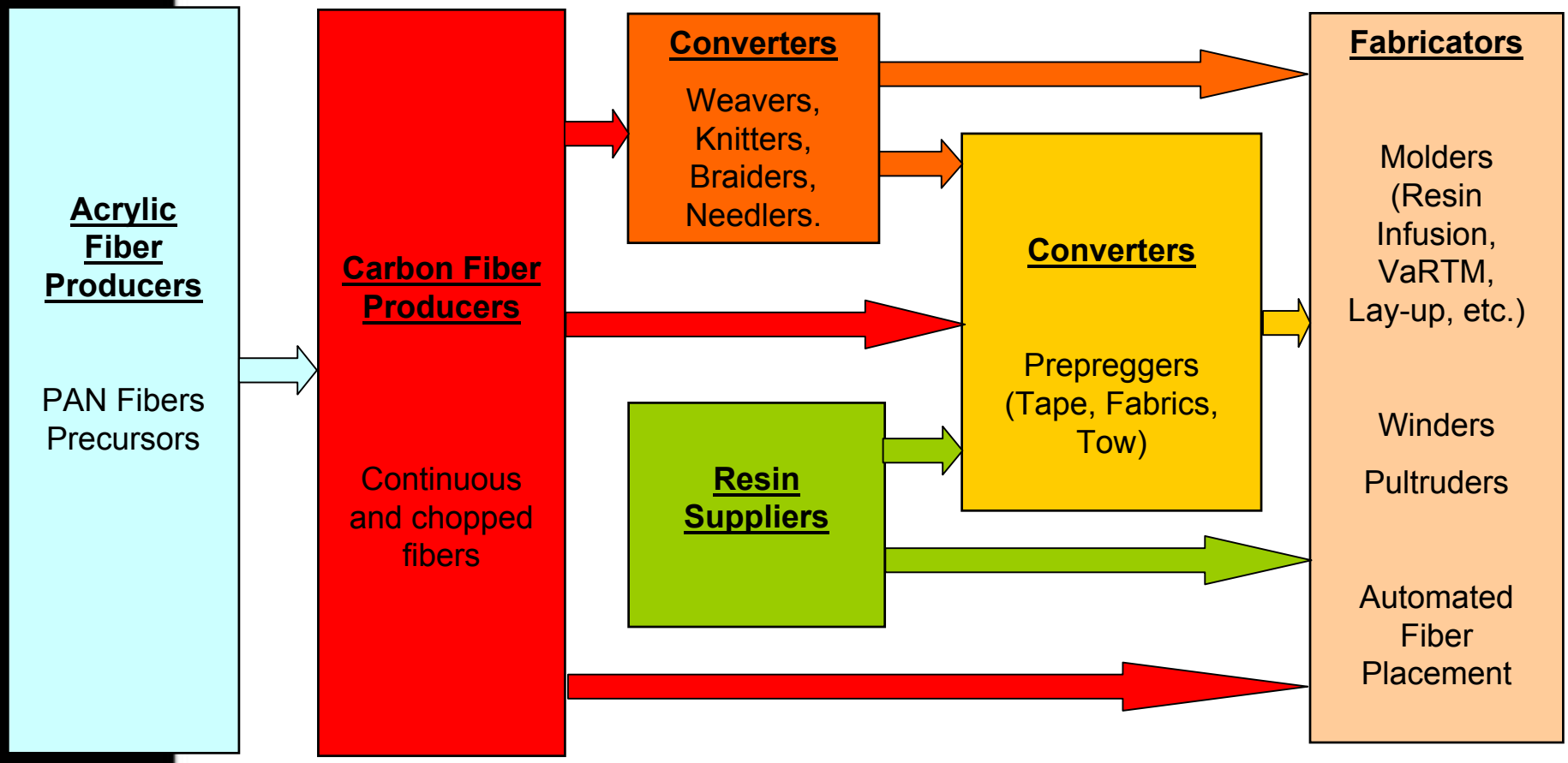
SUPPLY vs. DEMAND



CARBON FIBER SUPPLY CHAIN

NON-VERTICALLY INTEGRATED SUPLIER

(multiple profit centers, each with limited control over feed supply and scope of development)

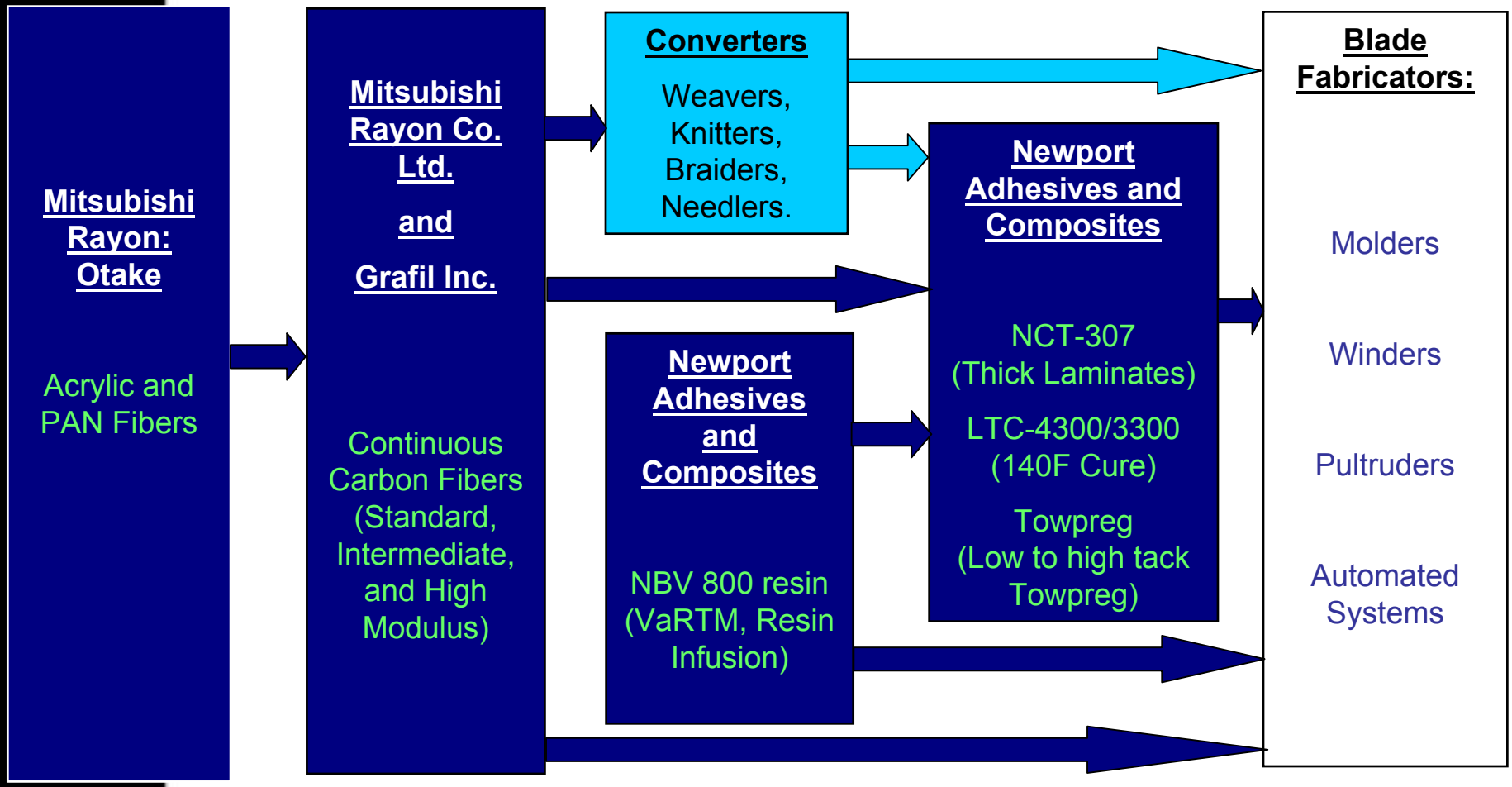


MITSUBISHI RAYON

Carbon Fibers and Advanced Materials Division

VERTICALLY INTEGRATED SUPLIER

(one partner with multiple product formats and unlimited control over production and development)



PARTNER CRITERIA

for large volume application, such as wind energy

Mitsubishi Rayon

Scope of supply and development

PAN Precursor → **PAN Filaments (Quality fibers from a large plant with good economy of scale)**

Carbon Fiber → **Continuous Fiber** →

HS/HT:TR 30/40/50, TRH 50, 34-700, 34-600
IM: MR60H, MR 40, MR 50
HM: MS 40, HR40, HS 40, SR 40

Prepregs and Adhesives →

Low Temp Cure & Thick Laminates

Formats: UD Prepreg:
Fabric Prepreg
Prepreg Tow
Preplied Prepreg

Resins → **Resin Infusion, VaRTM**

Thank you for your time

Grafil Inc.

The

END