Carbon Fiber Manufacture in Australia?

www.carbon-fiber.com
The ongoing shortage of PAN based carbon fibers has seen the planning, development and realization of new carbon fiber manufacturing capacity in new countries.

The start up of new plant faces many hurdles, especially in the face of competition that has been in the business for many decades.

However these hurdles have been overcome and this process will enable carbon fiber to become truly a commodity product, available to the vast range of current and new composite applications.
URGENT NOTICE!

Due to the severe global shortage of carbon fiber, and in order to continue shipping SOME carbon fabric to our customers, Carbcom will be limiting purchase quantities and temporarily eliminating bulk pricing.

We deeply apologize than Carbcom cannot be the aggressive price leader we have been up until recently, and we hope in the future you will buy larger quantities again when we are able to secure the volume of fibers we need to serve you with full shipments at great pricing!

Toll-free 1-888-CARBCOM / (888-227-2266)
International call: 1-808-579-8000
The Big 2, Toho Tenax and Toray

PAN Precursor (raw material) Made in Japan and exported to their overseas subsidiaries

Global Structure of Toho Tenax

The structure of Toray is similar, with plants in Japan, USA and France

Toho and Toray control over two thirds of carbon fiber manufacture globally
Mechanical Properties of PAN based Carbon Fibers

- **Tensile Strength (MPa)**
  - Low cost: 3000 MPa
  - Standard Grade: 4000 MPa
  - Advanced Grade: 5500 MPa

- **Tensile Modulus (GPa)**
  - Low cost: 350 GPa
  - Standard Grade: 450 GPa
  - Advanced Grade: 550 GPa
Mechanical Properties of PAN based Carbon Fibers & some typical applications.

- Intermediate modulus fiber
- Ultra high tenacity fiber
- High tenacity fiber
- Lower strength fiber
- High modulus fiber

Low cost ■ Standard Grade ▲ Advanced Grade
PAN Carbon Fiber Process
PAN Carbon Fiber Process

-CH₂-CH-CH₂-CH-
|    |    |
CN  | CN

- Specially developed PAN (PolyAcryloNitrile) fibers for the carbon fiber industry, using traditional technologies of acrylic textile fiber manufacture.

- Most carbon fiber companies manufacture their own precursor, using in house technologies. Variables include type of solvent, type and amounts of co-monomers, degrees of fiber shrinkage and stretching in the manufacturing process.

- For high performance carbon fibers, the fibers are collected in bundles of 1000 (1K) to 24000 (24K) filaments. The bundle of filaments is commonly referred to as a “tow”.

- PAN tows are usually supplied on spools of up to 50kg weight. These are placed on a precision creel to allow one tow to run next to another to make a towband or sheet of tows, which are transported through the carbon fiber process.

- For the manufacture of lower grade carbon fiber, some commercial textile acrylic fibers are supplied in boxes of up to 300kg weight. These contain a continuous crimped sheet of up to 350000 filaments. Several of these “heavy tows” are transported together though the carbon fiber process in a towband. Not all commercial textile acrylic fibers are suitable for conversion to carbon fiber.
PAN Carbon Fiber Process

Oxidation (Air to 300°C)

\[-\text{CH}_2-\text{CH}-\text{CH}_2-\text{CH}-\]
\[\text{CN} \quad \text{CN}\]

\[\xrightarrow{\text{O}_2, \text{heat}} \]

\[\begin{align*}
\text{CH} & \quad \text{CH} \\
\text{C} & \quad \text{C} \\
\text{N} & \quad \text{N} \\
\text{C} & \quad \text{N} \\
\text{C} & \quad \text{NH}
\end{align*}\]

+ HCN, CO₂, Δheat

Converts the molecular PAN ladder, to the stable oxidized PAN ring structure.

Volatile hydrogen is evolved and less volatile oxygen is absorbed into the ring structure.

The process is extremely exothermic, fires in oxidation ovens are not uncommon.

The stability of the fiber allows further processing, under Nitrogen to higher temperatures.

Oxidized PAN is flameproof and is produced commercially as a fire resistant textile fiber.
PAN Carbon Fiber Process
Carbonization
PAN Carbon Fiber Process

- The electrically conductive carbon fibers become the anode in electrolysis in a salt solution such as ammonium sulfate.
- This causes carboxyl groups such as COOH to form on the smooth fiber surface.
- The carboxyl groups improve the cohesion between the fiber and the resin used in the final composite.
- After surface treatment excess electrolyte is removed by a warm water wash treatment.
- The carbon fiber strands pass through one or more dip baths, with counter current water flow.
PAN Carbon Fiber Process

- Carbon fiber strands are pre-dried prior to sizing. This helps ensure a uniform "pick up" of sizing.
- A typical sizing is a dispersion of water and small epoxy particles. The water is dried off, to leave the filaments coated in an epoxy film. This enables ease of handling during further processing of the fiber (e.g. prepregging). Non-modified epoxy sizings are available for specialist applications. Winders can produce finished spools of up to 12 kg in weight.
PAN Carbon Fiber Process in Pictures

PAN Precursor Unwinding Creel (Courtesy of Texkimp Ltd.)
PAN Carbon Fiber Process in Pictures

Oxidation (Courtesy of Despatch Ltd.)
PAN Carbon Fiber Process in Pictures

Carbonization Furnace (Courtesy of Harper Int.)
The “end of the line”, carbon fiber being wound onto spools.

*Courtesy of Grafil Inc.*
Raw Material for PAN based Carbon Fiber: Acrylic Fiber
World Capacity of Acrylic Fiber Production:
Steady growth since 1990. Currently thought to be over 3000 000 TPA in 2010 production could reach near 4000 000TPA

What is current PAN based carbon fiber capacity?
World carbon fiber capacity in 2010 is anticipated to exceed 40,000 TPA

How much acrylic fiber do we need for that?
For 40 000 TPA carbon fiber, will produce around 80 000TPA acrylic fiber precursor

So if acrylic fiber production is 4000 000 TPA we can easily increase carbon fiber capacity right?! No! The vast majority of acrylic fibers are unsuitable for conversion to carbon fiber. This is mainly due to additives and co-monomers added to improve their performance in textile applications. However these hinder the thermal conversion required in the carbon fiber process.
How can any new manufacturers of carbon fiber get suitable acrylic precursor?

**Develop the precursor “in house”**
This route is thought to be happening in the PRC with assistance from educational institutes such as Beijing University.

**Current acrylic manufacturers develop some of their production for carbon fiber precursor**
This is happening at AKSA, in Turkey. Their site at Yalova near Istanbul has a capacity of 250 000 TPY of acrylic fiber. Following installation of a pilot line in 2008, commercial production of carbon fiber will begin in Autumn 2009, with 1500 TPA.

**Convert redundant acrylic fiber plant to precursor production (2008)**
Former Acordis acrylic fiber plant at Kelheim Germany. “Austria's Lenzing Group is expanding into the production of carbon fiber with the proposed formation of a joint venture – European Precursor GmbH – between its subsidiary Lenzing Plastics GmbH and two German partners—SGL Carbon AG of Wiesbaden and Kelheim Fibers GmbH from Kelheim.”
Bluestar Fibres provide the precursor that allows the Carbon Fibre to be made. CFP (Carbon Fibre Precursor) is continuous filament acrylic tow made to precise specifications, for conversion into oxidised and carbonised fibres, for use in a broad range of aerospace, sporting goods and industrial applications including golf shafts, wind turbine blades, mobile phones, aircraft brakes, automotive, fire retardant clothing and other high strength products. – Source www.blustarfibres.com

The Grimsby (UK) plant was finally acquired, after a failed management buy-out, by the China National Bluestar Corporation in 2007.
Bluestar Fibers in Grimsby UK have a capacity of 80,000 TPY of acrylic fiber available for conversion to carbon fiber. Formerly a major manufacturer of acrylic fiber for textile applications, the company concentrates purely on carbon fiber precursor and sells to the open market.

Conversion of all precursor from this one facility would double global PAN based carbon fiber capacity!
In Summary

With supply of precursor, new carbon fiber plant capacity could be built almost anywhere. For carbon fiber plant hardware, there are at least two suppliers.

Current carbon fiber plants for example in Japan, France, Germany and the USA are not in low cost labor countries.

This low volume high value business is ideal for a country such as Australia. A solid and expanding composites industry will be well supported with a local source of carbon fiber.
Thank you!

vince@carbon-fiber.com
www.carbon-fiber.com