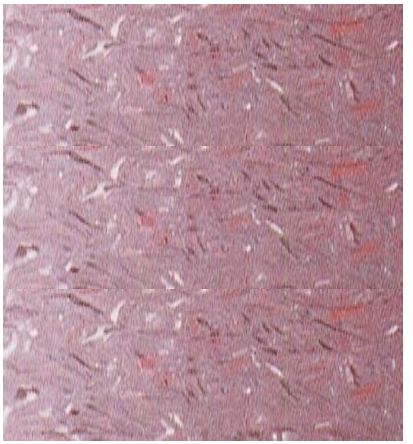
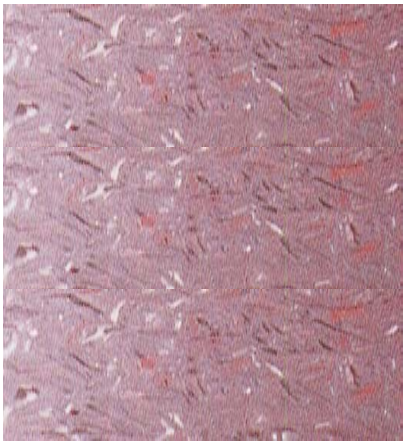


# Industrial application:

Fibres and Fabrics

# Fibres and Fabrics



- Fibres
  - Definition
  - Application
  - Fibre composites
- Fabrics
  - Definition
  - Application
  - Properties
- Carbon fibre reinforced plastics
  - Definition
  - Application
  - Advantages
  - Typical prepreg properties
  - Component figuration of fibres
  - Prepreg composites properties

# Carbon fibres

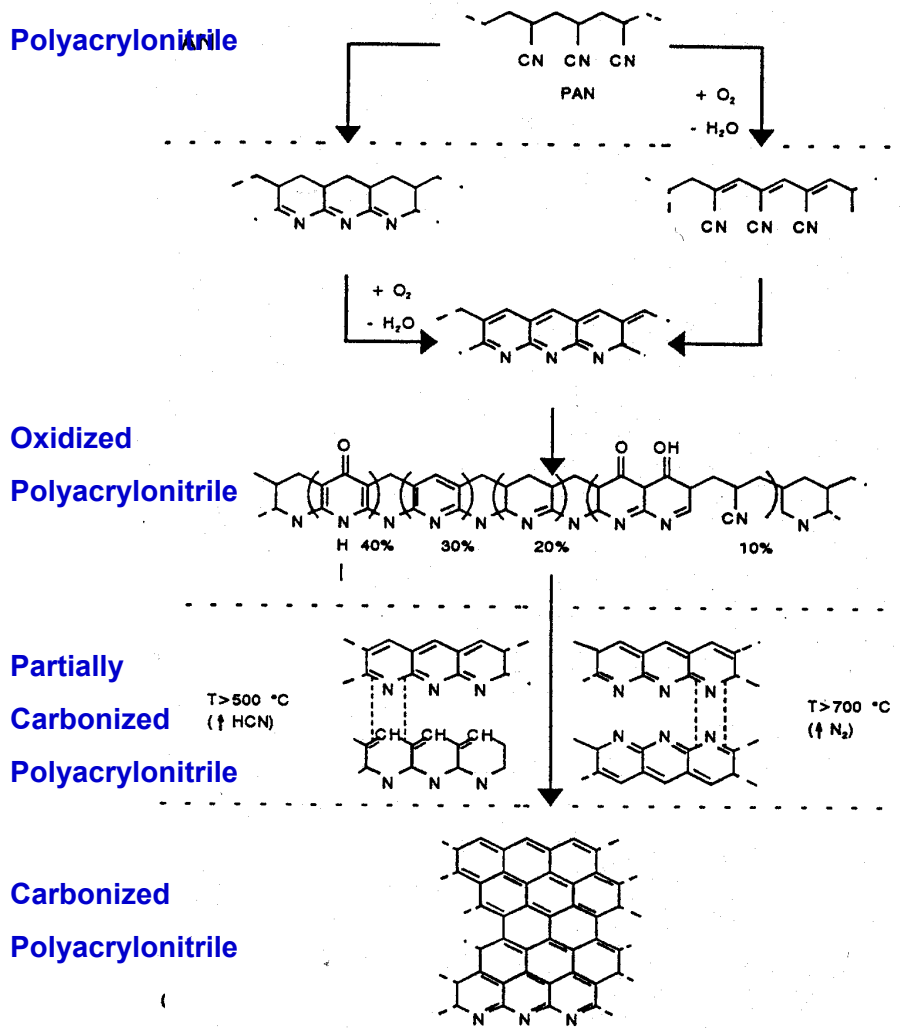
**Definition**

Since technical grade carbon fibres were developed in the mid 1960s, they have been gradually introduced in technical products. The application is connected with material questions such as matrix materials, fibre/matrix adhesion promoters and long term behaviour, component production techniques or textile semi-finished materials. Precursors for carbon fibres can be rayon, polyacrylnitril or pitch. Depending on applications carbon fibres can even be graphitised.

The production process

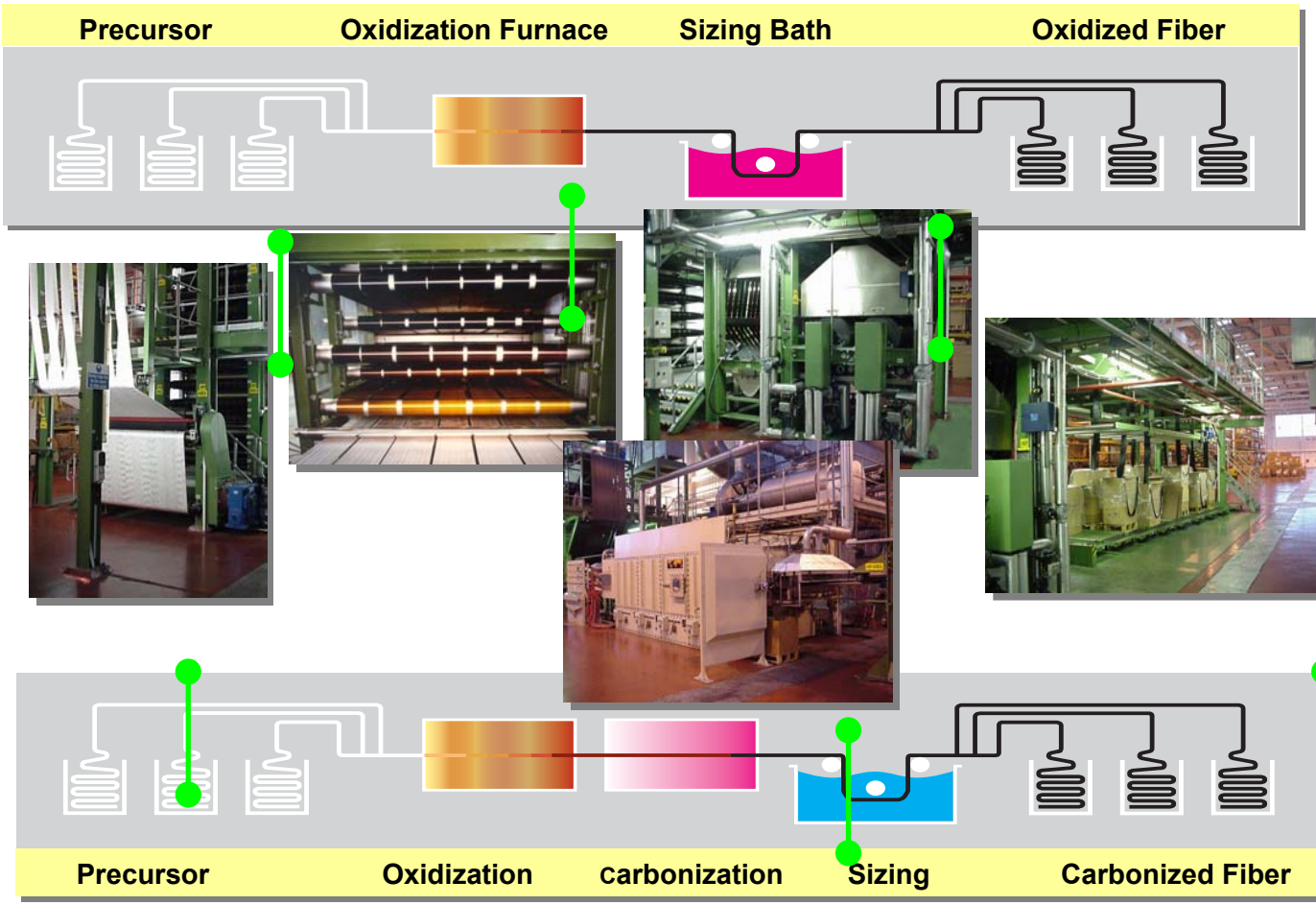
# Production of PAN Fibers

## Pyrolysis Mechanism of the Carbon Fiber Prozess




| C | H | N | O | [w%] |
|---|---|---|---|---|
| 65 | 6 | 25 | 3 | |
| 60 | 4 | 20 | 14 | |
| 72 | 2 | 18 | 7 | |
| 95 | 0,3 | 4,5 | 0,2 | |

# Production Process of Carbon Fibers



# Carbon fibres applications

**Carbon fibres applications:**

Carbon fibres are applied in flat and tubular components, for supports, rods, and as reinforcements as well as in special components.

Textile components – components for radiography equipment – components produced by filament winding – components for measuring technology and optical equipment – components for automation – components for general machine construction

# Carbon fibres

**Fibre composites**

Fibre composites can be used in machine, equipment and apparatus construction, medical technology and vehicle building.

# Carbon fabric

**Definition**

When the fibres are processed into knitted or woven artefacts, they make up a fabric.

**Applications of carbon fabric**

This fabric can be used for interior furnishings, protective clothing or as industrial applications for packing and gaskets.

# Carbon fabric: characteristics

High tensile strength

High Young's modulus

Carbon content > 99%

Suitability for reinforcement

Electrical conductivity

Fibre sizing adapted to end matrix
or respective application.

# Carbon fibre reinforced plastics

**Definiton:**

Fibre-reinforced plastics are composite materials with tailor-made properties. Reinforcement fibres are embedded in a matrix of resin.

# Carbon fibre reinforced plastics

**Properties**

The properties of the fibre-reinforced plastic articles are governed mainly by the properties of the fibre, in particular the carbon fibre, and the form of textile into which the fibre is processed.

Pre-impregnated materials (prepregs) offer a precise and economical way of combining reinforcements with a resin matrix. Prepregs consist of high-quality textile fabrics impregnated with curable resins. The fibre type is the main factor governing the strength, Young's modulus and other important properties of fibre composite products.

High strength, rigidity and pronounced anisotropy are achieved by a unidirectional (UD) arrangement of the fibres or the prepregs themselves. As the fibres are arranged in dense bundles, the unidirectional prepregs contain at least 60 percent fibres by volume. In principle, prepregs made from woven fabrics are employed for components that have to be isotropic in one plane (orthotropic). This can be achieved with plain-weave fabrics, in which warp and weft are arranged at angles of +45°/-45° and 0°/90° to the main axis of the laminate. In general, the fibre content of such elements will be about 50 percent by volume. Not only does the resin influence the essential properties of the resulting products, but it also determines their processibility, manufacturing time and cost.

# Properties of reinforced plastics

**Properties at a glance**

- superior mechanical, dynamic and chemical properties in comparison with conventional

- isotropic materials (metals, plastics, ceramics)

- low density and mass

- high rigidity and strength

- high fatigue strength

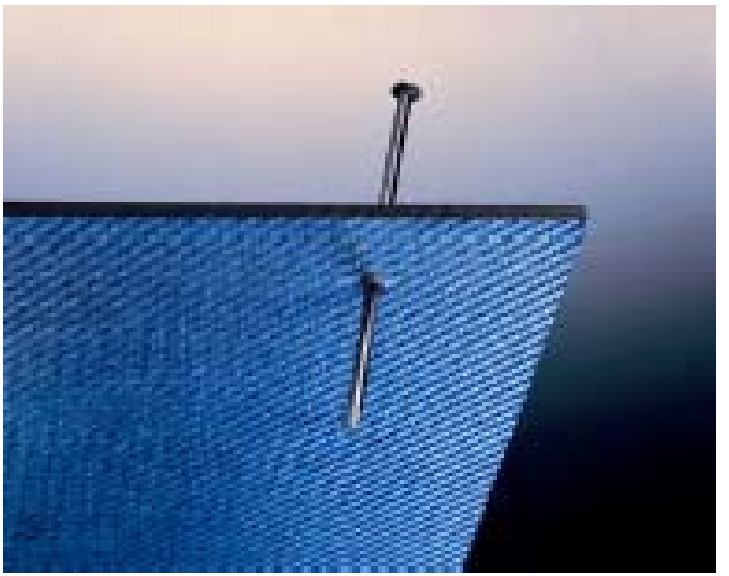
- very good corrosion resistance

- suitable for integral construction techniques

# Carbon fibre reinforced plastics: applications

**Applications**

The materials currently used are glass, aramid, carbon and graphite fibres in combination with epoxy and phenolic resins. Elements manufactured from fibre composites can be designed in such a way that they exactly meet the requirements imposed on them.



# Advantages of carbon fibre reinforced carbon composites

- Resistance to high temperatures and weathering, low flammability, low smoke density, low toxicity of decomposition products . Temperature resistance of course depends on choice of resin.
- High chemical stability
- Large variety of possible component shapes and sizes
- High durability due to long prepreg storage life.
- Prepregs comprise the range of reinforcements and resin matrix combinations. They are manufactured on a state-of-the-art fusible resin plant. Fusible resins have fewer volatile constituents and increase the composite materials' mechanical strength. The prepreg manufacturing plant is accredited to DIN AND ISO 9001 quality assurance standards

# Carbon fibre reinforced plastics: applications

An example:

# Typical prepreg composite properties

| **Property (as at room temperature)** | **Prepreg type** |
|---|---|
| Density g/cm³ | 1.58-1.57 |
| Shear strength N/mm² | 30-40 up to 80-90 |
| Young's modulus kN/mm² | 60 up to 215 |
| Tensile strength N/mm² | 950-2400 |
| Glass transition temperature, Tg, dry °C | 120-240 |
| Long-term heat resistance °C | Up to 120 – up to 180 |

# Table: Component figuration of fibres

| Component figuration | Fibre products |
|---|---|
| Flat components | - Woven carbon fibre fabrics, biaxial<br>- Hybrid materials woven from carbon fibres<br>- Unidirectional tapes or warp cloths<br>- Wound rovings with various fibre alignments |
| Tubular components | - Wound rovings with various fibre alignments<br>- Woven fabrics, tapes, monoaxial or biaxial<br>- Unidirectional prepregs |
| Supports, rods, reinforcements | - Carbon fibre or hybrid woven fabrics, biaxial<br>- Unidirectional prepegs |
| Special components | - same as above<br>- Fittings, inserts, foams, integral ribs |

# Prepreg composites: density, tensile strength and specific strenght compared to other materials