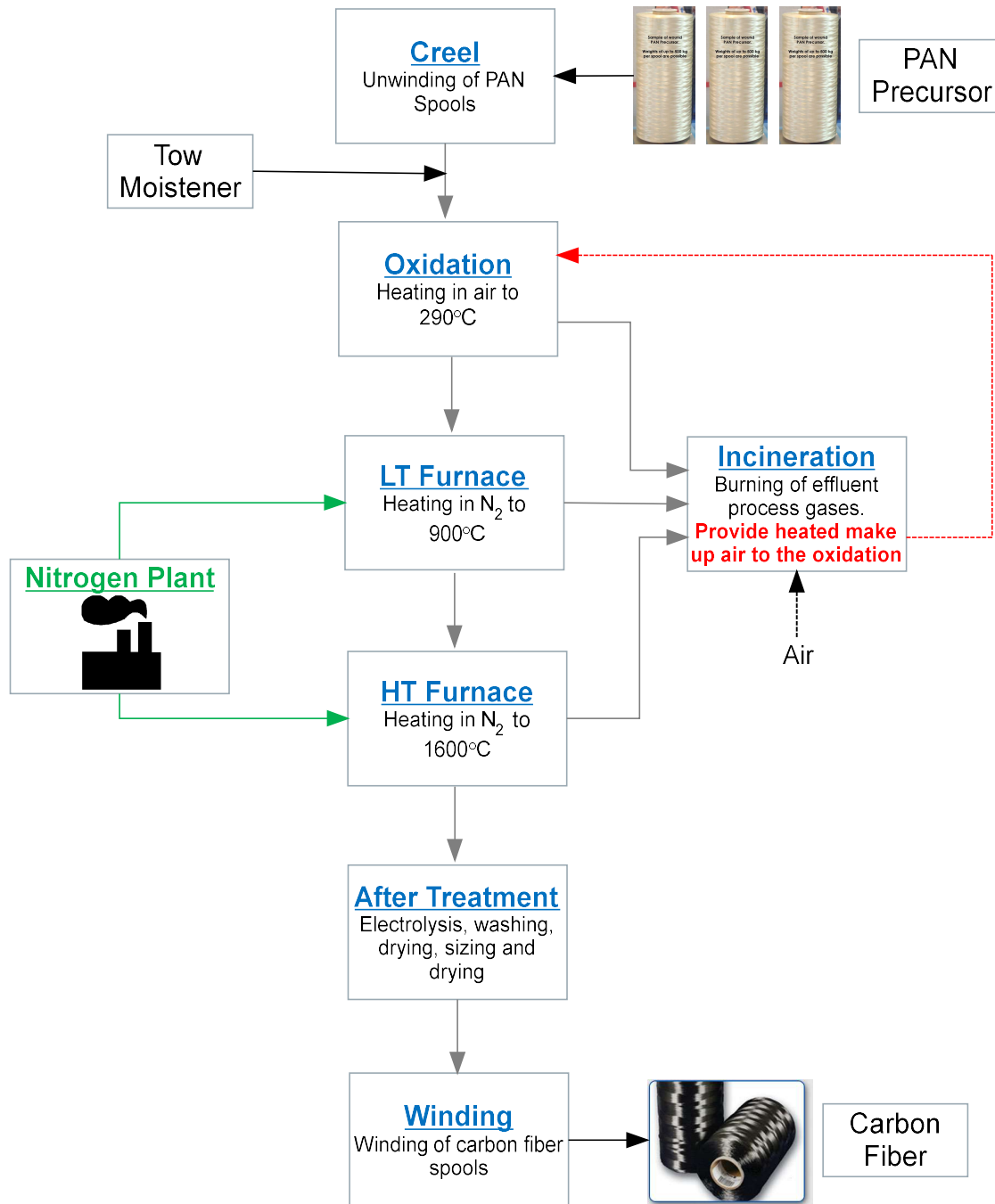


# Carbon Fiber Process & Quality Control



The carbon fiber process is a collection of heat treatment technologies combined with a series of tension stands and rollers to transport the towband through the process. The process should be set up in a way to produce the required output in tonnes per year and produce fibers of an agreed quality standard. A typical list of fiber properties to aim for, as required by the market and the capability of the precursor and process, is issued by the quality management section in conjunction with the sales department.

## Figure 1 Typical List of Primary Carbon Fiber Properties (e.g. T300; 24K)

Tensile Strength	3500 MPa
Tensile Modulus	230 GPa
Linear Density	1600 tex
Size Level (Epoxy)	1.50%
Fiber Density	1.75 g/cm <sup>3</sup>
Inter Laminar Shear Strength (ILSS)	70 MPa

In addition to the properties above, (which are quoted to customers) the laboratory measures the following properties, which are used internally:

### Fuzz Level

This test determines the fuzziness of the strand, important for processing at the customer.

### Coalescence

This test determines how many individual fibers are stuck together in a 24K sample. High coalescence count can be a cause of low tensile strength.

### Density

The density of fiber in the oxidation and after the LT and HT furnace are used to assess the effectiveness of the process conditions.

### Electrical Conductivity

Electrical conductivity after the LT and HT furnaces show the degree of carbonization in this part of the process

### Spool Hardness

The hardness of the spools is measured to ensure the spools are not wound too tightly or softly, which can cause problems during further processing of the fibers.

### Thermal Oxidative Stability

Determines the weight loss of the fiber, at elevated temperatures, in air.

### False Twist

Determines if any unintentional twist is being inserted in the fiber during the process.

### Functional Groups on Fiber Surface

Determines the amount of oxygen based chemical groups on the fiber surface.

In addition to measuring the primary and secondary fiber properties, regular measurement of strand tension in the process and the concentration of the surface treatment and sizing baths should be made. This along with good precursor and control of the process, should ensure a constant product quality.

## Process Control of the Primary Carbon Fiber Properties

### Tensile Strength

In the event of low tensile strength, the following plant parameters should be checked and corrected:

#### Major influence

Precursor quality (substitute some spools from another batch).

Nitrogen quality (check moisture and oxygen content).

HT Furnace (check temperature and fiber modulus).

Coalescence.

#### Minor influence

Oxidation (check oxidized density and strand rubbing on slits).

Tow moistener (check water quality).

LT Furnace (check temperature profile and clean removal of tar).

Surface Treatment (check treatment ampere).

Stretch and shrinkages in the whole process. (check roller speeds)

### Tensile Modulus

In the event of low or high tensile modulus, the following plant parameters should be checked and corrected:

#### Major influence

HT Furnace Temperature (reduce end temperature to reduce fiber modulus)

Stretch and shrinkages in the whole carbonization. (check roller speeds)

## Linear Density

In the event of low or high linear density, the following plant parameters should be checked and corrected:

### Major influence

Precursor linear density.

Speed of Tension Stand 1 (increase speed to increase linear density)

### Minor influence

Oxidation (check oxidized density).

LT Furnace (check temperature profile and clean removal of tar).

HT Furnace (check temperature and fiber modulus).

## Size Level

In the event of low or high size level, the following plant parameters should be checked and corrected:

### Major influence

Sizing bath concentration (reduce concentration to reduce size level)

### Minor influence

Sizing bath temperature (high temperature, lower size level)

Strand tension in sizing bath.

## Carbon Fiber Density

Carbon fiber density, varies from plant to plant. Providing the density remains in the range given, it should not be adjusted, as this can affect other more critical properties such as tensile strength and modulus.

## Inter Laminar Shear Strength (ILSS)

In the event of low ILSS, the following plant parameters should be checked and corrected.

### Major influence

Surface Treatment, check the energy level in the surface treatment process (if too low, ILSS will be less)

HT Furnace Temperature (too high temperature will reduce ILSS, check fiber modulus too).

### Minor influence

Surface Treatment bath temperature, extremes of heat or cold can influence the ILSS.

Vince Kelly