

Tires are trump

High-Tenacity Rayon Filament Yarn

PLIES: TREAD 2 STEEL + 1 ARAMID  
SIDEWALL 2 RAYON

CORDEMIKA<sup>®</sup>

## TIRES ARE TRUMP

Tires have a huge influence on riding comfort, steerability, and road holding. This is not surprising as tires are the only real contact between car and road. Tires not only have to cope with bad road surfaces, wet roads, high speeds, strong abrupt braking, and long distances, but also long periods of standstill. And they have to do so from the first to the last mile. When they are replaced, they must be still as round as when they were purchased.

### Pleasant motoring

Basic requirements:

- Safety – also at high speeds
- Good roadholding
- Prompt response to steering
- No vibrations
- Smooth riding without shocks

Tires play a decisive role in meeting these requirements. A car may be top-notch, but if its tires are bad, the driving characteristics will be poor.

### Role of reinforcing material

The quality of a tire - and thus its behavior during its useful life - is largely determined by the material used. A car tire is composed of rubber, reinforced with a fiber cord material in the casing. The reinforcing material is necessary because rubber itself does not have the structural stability required for proper handling and control of the vehicle.

### Dimensional stability

Uniformity is a prerequisite for a high-quality, high-performance tire. Lasting properties are elementary for retaining the original optimal driving characteristics, also after heavy and enduring circumstances and after exposure to high temperatures. Dimensional stability is therefore one of the basic requirements for carcass reinforcing material.

### Carcass reinforcement

The carcass is one of the most important parts of a radial tire, transferring all forces from the road surface to the rim, interacting with the belt package and providing flexible sidewall. As the carcass influences handling, comfort and safety its reinforcement plays an essential role regarding the quality of the tire and thus its performance and durability. The key fiber materials used for reinforcing the casing of car tires are:

- rayon
- polyester
- polyamide (nylon), and
- aramid



However, each carcass reinforcing material has its own physical properties and reacts differently to different influences.

Visco-elastic materials - such as rubber and textile cords - generate heat under alternating deflection. Since they do not cool down quickly, repeated deflection causes the inside temperature to increase. Fighting heat and the effects thereof, therefore play a key role in designing, producing and using tires.

That is why the choice of reinforcing material is so very important for the tire's performance and durability.

*Impression of the temperature range in tires during driving:*

- Standard driving 60°C - 80°C
- Forceful driving 80°C - 100°C
- Forceful driving 100°C - 120°C
- In high ambient temperatures
- Nurburgring test conditions 120°C - 130°C
- Tire (deflated Run-flat) up to 180°C
- Tread Act USA (DOT 139) up to 146°C

**Overview of materials**

**Rayon**, based on cellulose from wood, has been applied as a reinforcing material for radial tires in Europe since the nineteen forties. Polyamide (nylon) and polyester originate from the United States and are of a later date. There they were initially used in bias-ply tires, ousting rayon. The radial tire was introduced there much later than in Europe. As polyester was more readily available in the United States than rayon, and with performance requirements being less strict in the USA, mainly the cheaper polyester was used for radial tires.

Since the eighties, the number of polyester-reinforced radial tires has risen in Europe as well. For high-performance tires, however, rayon is still top of the list. Polyamide is principally used as reinforcement for specific car tire components, and for trucks, buses, and agricultural vehicles.

Amid, an exceptionally properties. Polyamide, fibers made from

**TWO MAIN CLASSES OF FIBERS**

**From flexible-chain polymers**

**Thermoplastic:**  
**Heat sensitive**

Become viscous and melt when warmed up

- Polyester
- Polyamide

**From rigid-chain polymers**

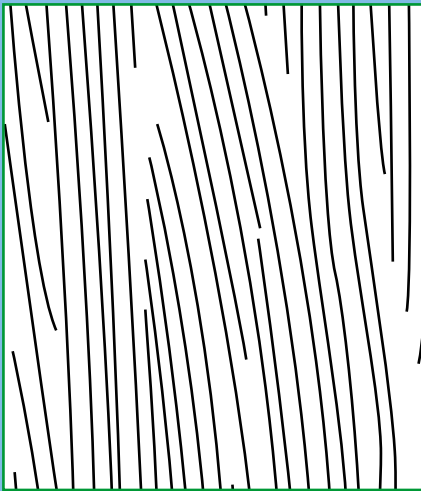
**Thermostable:**  
**Hardly affected by heat**

Don't melt. Tend to carbonize at extreme temperatures

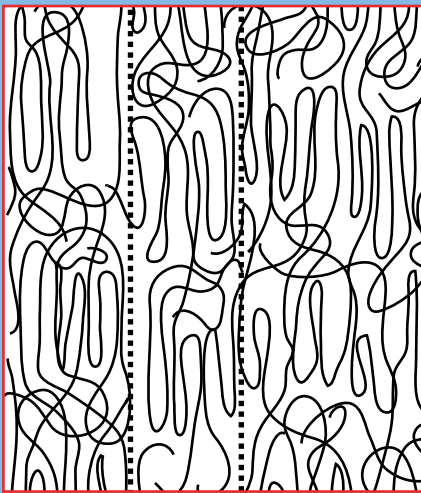
- Rayon
- Aramide

## FIBER STRUCTURE

### Thermostable Rayon



### Thermoplastic PET



## Properties

**Cordenka** has tested and compared various materials and has assessed their suitability for use in passenger car tires. Tests have been performed simulating all stages in the life of a tire's casing, from production to long-time use. The test results once more confirm beyond doubt that rayon is better than polyester or polyamide. Rayon's constant dimensional stability is a guarantee for quality from the beginning to the end of a tire's life. It means:

- perfect roundness (rolling comfort)
- best track stability (steering properties), and
- constancy up to the last mile

Perfectly round quality tires are obtained through low elongation (high modulus) and none or very low shrinkage.

When the tire must perform well in all sorts of conditions very low elongation during motion (high dynamic modulus), has a favorable effect on the car's steerability. Rayon performs by far the best, staying constant over time, no matter how hot the tires get even after a long journey in smothering heat with a heavy load.

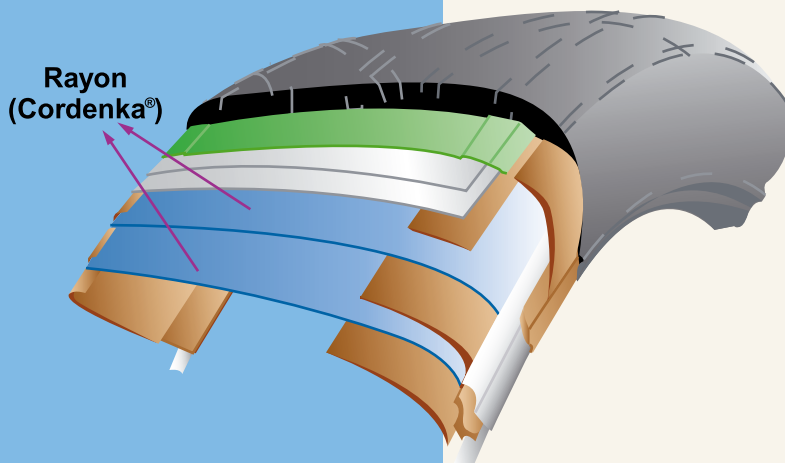
Rayon keeps its length. It does not 'creep' or 'grow.' That is why the casing always retains its original shape. Consequently, the rolling and steering characteristics of the tire stay the same, even under exacting conditions. And this will be the case during the tire's entire life cycle.

Rayon owes its resistance to heat and stress to its cellulose origin. The material is thermally stable. Polyester and polyamide are based on oil. They are thermoplastic and are therefore affected by heat and stress. They show higher shrinkage, higher elongation, and more creep.

The only synthetic fiber that – like rayon – is insensitive to heat and stress is aramid. However, the use of aramid in the casing of passenger car tires is relatively expensive and practical problems occur due to the too high stiffness of the material.

Rayon amply meets all relevant requirements.

Cordenka rayon's suitability for carcass reinforcement of high quality tires is not only apparent during the production process, but even more importantly, on the road and during the tire's entire life.



### Production

A high quality tire must be perfectly round and straight, which means that it does not jolt or oscillate. In order to produce such a tire of high 'uniformity' a low-stretching reinforcing material must be used for the assembly of the tire whereas the curing requires a non-shrinking material. After curing, the inflated tire should not suffer from indentation on the spot of the carcass joint. Rayon meets all requirements with flying colors, which is certainly not the case with polyester and nylon. The ease of impeccable manufacturing obviously minimizes the reject-rate in tire production.

### On-the-road functioning

The handling is checked by test drivers of the car manufacturers.

They check whether the tire's response is direct enough and whether the tire still feels the same after some half hour's drive to the limit, comparable to a long journey in smothering heat with a heavy load.

Under dynamic circumstances rayon hardly stretches; this is substantially less than polyester and extremely less than nylon.

Particularly under heavy and enduring circumstances, that provoke high temperatures, rayon withstands elongation, thus contributing to the agility of the car.

### Consistent performance until the last kilometer

Do the uniformity and handling characteristics (no jolting and no oscillation) remain the same even after 80,000 or more kilometers, regardless of long journeys under difficult circumstances?

The answer: rayon hardly shows any permanent elongation. It does not creep. The result is that the contours of the tire's side walls remain unchanged, the response of the tire is unaffected and uniformity maintained until the very last kilometer.

Rayon inside the tire body ('carcass') provides:

- the best roundness and straightness for *smooth, vibration free running*
- the best contribution to vehicle *agility* – response to your steering wheel, irrespective of tough conditions (load, temperature, enduring speed)
- *lasting performance*, constant excellence up to the last mile
- avoidance of flat spotting after hot tires have cooled down



### **Run-flat tires**

Run-flat tires are becoming increasingly popular due to new developments in design and manufacture. Run-flats offer added safety and convenience enabling a driver to travel at least 80 kilometers at 80 km/h without having to stop to change a deflated tires. Run-flat tires have a thicker and stiffer sidewall to support the car when the air pressure is gone.

A thicker sidewall causes more heat generation and is less efficient at dissipating the heat generated when driving. The resulting steep increase in temperature degrades thermoplastic reinforcing materials and the rubber when the tire is punctured and used at zero pressure.

Because of their physical structure, non-thermoplastic Cordenka rayon yarns feature low heat build-up and high resistance to heat and stress and are therefore the only appropriate reinforcement for state-of-the-art run-flat tire types.

## **GLOSSARY OF TERMS REFERRING TO TIRE REINFORCEMENT**

### **Dimensional Stability**

The ability of material to maintain or return to its original size (geometric configuration).

### **Creep**

Time-dependent deformation exhibited by material subjected to a continuing load; creep can be recoverable or irrecoverable following removal of the applied load.

### **Growth**

The irrecoverable component of creep.

### **Shrinkage**

Contraction of a fiber after/at exposure to elevated temperatures.

### **Stress**

The tension/compression situation in a component/product resulting from a force on that component/product. Usually expressed in force per unit cross section.

### **Filament**

A fiber of indefinite or extreme length.

### **Yarn**

Continuous strand of textile filaments.

### **Cord**

The product formed by twisting together two or more yarns or by twisting or placing together steel filaments or strands of steel filaments.

### **Dipped cords**

Cords of yarns impregnated to add a layer of material necessary for adhesion to rubber

### **Tire cord fabric**

Flat layer of parallel tire cords connected by widely spaced weft material (just for handling during further processing steps).

### **Dipped tire cord fabric**

See: tire cord fabric; after impregnation step.

### **Stiffness**

Generally, resistance to deformation under load. In the fiber and tire industries more specifically: resistance to bending.

### **Ply**

A layer of parallel cords or fabric.

**Cap ply**

A ply placed outside the carcass with cords/twisted yarns, placed in circumferential direction to stabilize the belt, especially the belt edges under inner pressure and centrifugal force.

**Carcass**

The rubber-bonded cord structure of a tire, including the bead, which contains the inflation pressure

**Belt**

A layer, or a number of layers, of reinforcing material underneath the tread, mainly placed in the direction of the tread centerline, which restricts the carcass in a circumferential direction.

**Tread**

Part of the tire designed to contact the road.

**Beads**

The parts of the tire shaped to fit the rim.

**Sidewalls**

The parts of a pneumatic tire connecting the bead and tread.

**Radial Tire/Radial Ply Tire**

A pneumatic tire in which the cords extend to the beads and are mainly laid at 90 degrees to the centerline of the tread, the carcass being stabilized by an essentially inextensible circumferential belt.

**Rim**

The part of the wheel onto which the tire or tire and tube are mounted and supported.

**Thermostability**

Preservation of mechanical properties at elevated temperatures.

**Thermoplastic**

Characterized by loss of mechanical properties and original geometry (size) at elevated temperatures.

**Polyamide \***

Polymer characterized by the presence of the amide group. Nylon is the most familiar name. The material is derived from oil and the fiber is made in a melt spinning process.

*\* Polyamide 6.6 is obtained from polycondensation of hexamethylene diamine and adipic acid.*

**Nylon**

Originally a brand name. See: polyamide.

**Polyester \***

Polymer characterized by the presence of the ester group. The material is derived from oil. The fiber is made in a melt spinning process. It has improved dimensional stability compared to polyamide (nylon).

*\* Product of the polycondensation of dimethyl terephthalate and ethylene glycol.*

**Rayon \***

Fiber derived from wood pulp produced in a chemical process by means of wet spinning and subsequent drying. The fiber is characterized by a high dimensional stability.

*\* Man-made fiber based on regenerated cellulose*

**Aramid \* better known as aromatic polyamide**

Fiber with a special structure derived from oil and made in a wet spinning process, featuring very high strength and high dimensional stability.

*\* Substitution of the aliphatic carbon backbone in polyamide with aromatic groups leads to a considerable change in properties.*

**Steelcord**

Cord consisting of (strands of) steel filaments placed or twisted around each other.

**Modulus**

Theoretically, the force required for 100% elongation of a material. In practice, it is the relation between force and deformation.

**Dynamic modulus**

The relation between force and deformation under dynamic load or dynamic strain.

**HMLS**

High Modulus, Low Shrinkage - abbreviation used to indicate the category of polyester tire yarns with the said combination of properties.

**Elongation**

Deformation in the direction of the load caused by a tensile force.

**Breaking Load**

The maximum load (force) for a specimen in a tensile test carried to rupture.

**Work Loss**

(Amount of) energy transformed into heat through deformation of material.

**Heat generation**

See work loss.

**Hysteresis**

Energy lost through heat during dynamic operation.

**Cord twist**

The amount of twist (turns around the axis of a cord) per unit length of a cord.

**Cord distribution**

The measure of regularity with which cords are positioned in a ply.

**Fatigue**

Gradual weakening due to repeated deformation.

**Fatigue Resistance**

Capacity to withstand repeated deformation without weakening.

**Layer Strength**

The strength per unit width of a layer of tension members (e.g. cords in a carcass layer/fabric) in the direction of the tension members.

**Monoply**

Name of a carcass consisting of one layer of cords.

**Multiply**

Name of a carcass consisting of more than two layers of cords.

**Two-ply carcass**

A carcass consisting of two layers of cords

**Lasting Performance**

Initial performance unaffected until the end of the product's life.

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