



## Materials - Kevlar®

After our description of what happens on the inside of an exhaust system (see: "The birth of an exhaust system" in the section Technical Information) and how a new system is born between the oil-stained hands of our engineers (and not on a designer's table), here's a new series in which we present the materials that are used for the production of our exhausts and silencers. Apart from *classic* materials like aluminium and stainless steel, Giannelli operates titanium, carbon fiber and Kevlar®.

Through our website we have received numerous questions on the materials we use, and especially on Kevlar®. Even though this fiber has many applications in everyday life, it is relatively unknown. Therefore, we will start our series with Kevlar®...

### INVENTION

Kevlar® was discovered (or better: created) in 1965 by Stephanie Kwolek and Herbert Blades during research in the corporate laboratories of Dupont, a company that started its activity as manufacturer of explosives, but changed its objectives about a century ago, dedicating itself to the invention and production of chemical materials (other milestones in the DuPont history are the creation of Nylon®, Teflon®, Lycra® and Cordura®).

Kevlar was commercially introduced by Dupont in the 1970s. Kevlar® is a registered trademark (hence the ®).

### CHARACTERISTICS

Kevlar® is an *aramid*, an abbreviation for the term *aromatic polyamide*. The precise chemical composition of Kevlar® is *poly-para-phenylene-terephthalamide*, also known as a *para-aramid*. Aramids belong to the family of nylons. Common nylons do not have very good structural properties, so the *para-aramid* distinction is important. The *aramid ring* gives Kevlar® thermal stability, while the *para* structure gives it high strength and modulus.

Kevlar®'s *para-aramid* fibers possess a remarkable combination of properties that led to its adoption in a variety of uses since its commercial introduction in the early 1970s. The long molecular *poly-para-phenylene-terephthalamide* chains of Kevlar® are highly oriented with strong interchain bonding, resulting in a unique combination of properties:

Kevlar® has a high tensile strength at a low weight, structural rigidity, low electrical conductivity and high chemical resistance, low thermal shrinkage and high toughness, excellent dimensional stability and high cut resistance (because of its strength, Kevlar® is very difficult to cut. One needs special scissors for cutting dry fabric or prepreg, and special



drill bits for drilling cured laminates. The cutting of cured laminates without fraying is very difficult). Kevlar® is flame resistant and self-extinguishing.

Kevlar has other advantages besides weight and strength: like graphite, it has a slightly negative axial coefficient of thermal expansion, which means Kevlar laminates can be made thermally stable. Unlike graphite, Kevlar is very resistant to impact and abrasion damage. It can be used as a protective layer on graphite laminates. Kevlar can also be mixed with graphite in hybrid fabrics to provide damage resistance, increased ultimate strains, and to prevent catastrophic failure modes.

## APPLICATIONS

The application possibilities for Kevlar® are endless:

Kevlar® is used in automotive parts and in run-flat tires that allow for greater safety because they won't ruin the rim when driving to the nearest assistance.

It is used in shrapnel-resistant shielding in jet aircraft engines that will protect passengers in case an explosion occurs and in gloves that protect hands and fingers against cuts, slashes and other injuries that often occur in glass and sheet metal factories.

On an equal weight basis Kevlar® is 5 times stronger than steel, yet, at the same time, it is lightweight, flexible and comfortable. Because of these properties, Kevlar® quickly became the technology of choice for bullet-resistant vests. In fact, police officers have relied on the Kevlar® brand for more than 25 years because of the superior bullet-stopping power it offers. That power and protection comes packed at an extremely light weight, which provides both comfort and freedom of movement to those that wear Kevlar®.

The small-diameter, lightweight ropes that hold 22,000 pounds and help moor the largest U.S. Navy vessels are made of Kevlar® fibers, and in the ropes that secured the airbags in the crucial landing apparatus of the Mars Pathfinder.

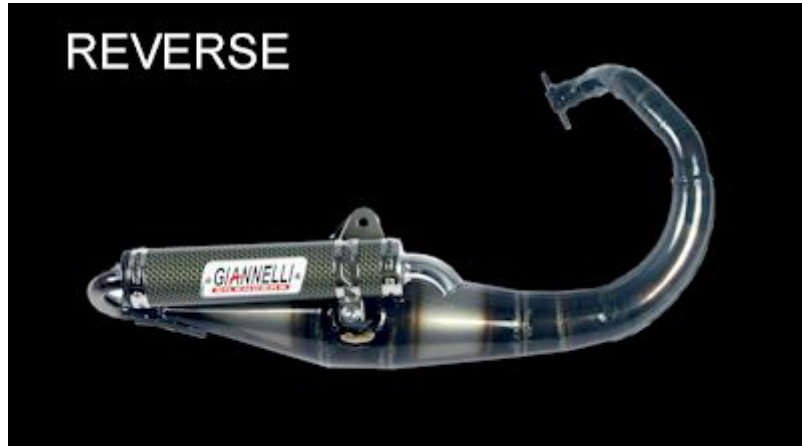
In sports, Kevlar® fibers are used to manufacture strong, lightweight skis, helmets and racquets that help lessen fatigue and boost exhilaration, as well as athletic shoes, hiking boots and parkas, and kayaks that provide better impact resistance with no extra weight.



## KEVLAR® & GIANNELLI

The primary job of the silencer, the final part of the exhaust, is to keep sound emission within the limits of the EU law.

By reducing the sound, however, a silencer interferes radically in the way combustion gasses find their way to the exit of the exhaust (see "The birth of an exhaust system"). After having traveled along a corridor of a certain width (the first part of the exhaust, the part we call it's "lung"), gasses and pressure waves bounce into the very narrow inside pipe of the silencer, the last part of the exhaust system. Because of this sudden space reduction, there's a pressure build-up on the inside of the pipe and a significant rise of the temperature (up to 400° Celsius).

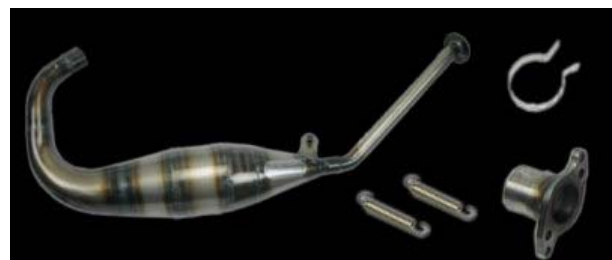


Scooters (and the pipes that are on it) are not always treated with velvet gloves, as you, warriors of the street, certainly know. Often, the streets have (not always very pleasant) surprises for your dampers, and the same goes for your exhaust system (sudden holes in the asphalt, high sidewalks that you run into, other vehicles, and-so-on). Therefore it's very important that your exhaust system is strong enough to swallow these blows (and not choke on them).



For it's capacity to absorb the blows and bounce back instead of breaking, and for it's resistance against heat, Kevlar® is the ideal material to use in high quality exhaust systems.

For your scooter, Giannelli's R&D dept. developed REVERSE, an exhaust homologated to EEC standards. The REVERSE has a handcrafted body and a silencer made of stainless steel covered by a shell in Kevlar® fiber. The main body of the exhaust is made of high quality stainless steel, and welded applying the classic oxyacetylene welding process. The body contains a perforated counter cone covered with sound absorbent material specifically made to guarantee maximum performance along with contained noise emissions. The look of





the system is aggressive and racy. We chose a transparent protective varnish to keep welding lines visible. When necessary, we included transmission springs and variator rolls in the exhaust kit. Replacing stock springs and rolls with the ones included in the kit will further enhance your scooter's performance.

For the best selling STREET 2Ts (Aprilia, Cagiva, Derbi, Honda and Yamaha), Giannelli developed a line of exhausts to enhance their performance. Our STREET 2T-systems are composed of an expansion body in high quality stainless steel, assembled through the classic oxyacetylene welding processes. The silencer is handcrafted and available in Kevlar®, in carbon fibre, or in aluminium. The exhaust is covered with a transparent varnish layer that protects the exhaust without covering its welding lines. The STREET 2T-exhausts come in racing as well as in EEC street-legal versions.

**Giannelli Silencers - Research & Development Department**