November 2009

future materials

OFFICIAL PUBLISHER OF techtextil news

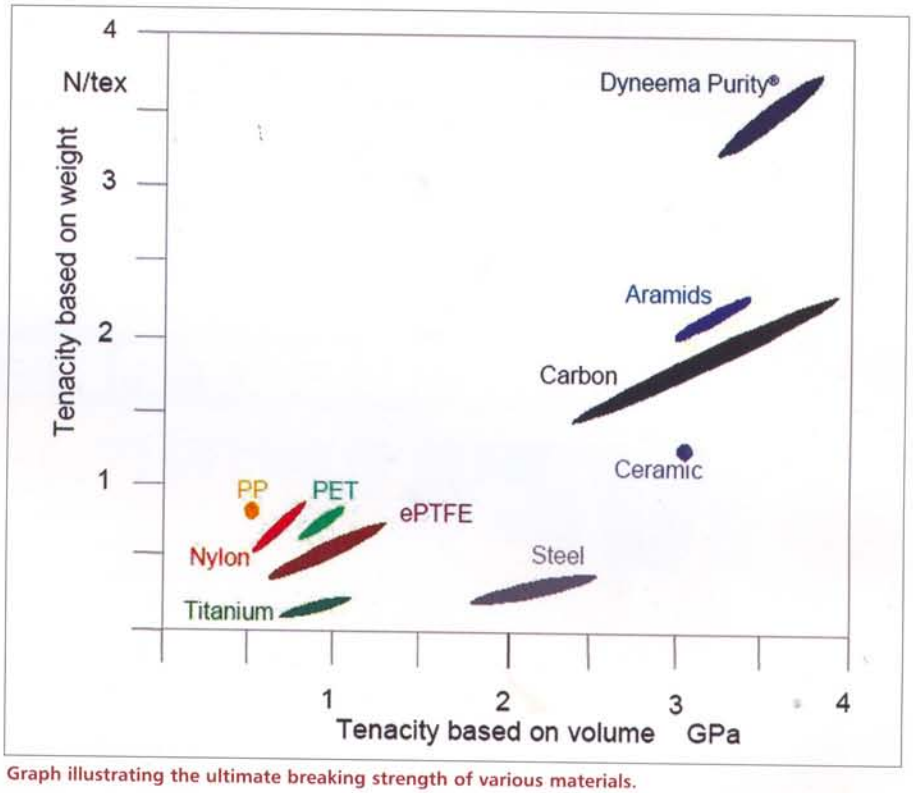
Flexible fibre advances

Recent developments in ultra high molecular weight polyethylene (UHMWPE) fibres are helping it enhance device performance and improve treatment results. Han Dols, business development manager Medical, DSM Dyneema, explains why

With the potential to substantially improve the performance of medical devices and positively impact patient outcomes, medical grade ultra high molecular weight polyethylene (UHMWPE) fibres, developed by DSM Dyneema, could provide a viable alternative to steel. Although steel has had decades of successful use in a broad range of orthopaedic, cardiovascular and other applications, recent advancements in polyethylene technology have supported the emergence of medical grade UHMWPE fibres that offer significant advantages over steel in bending flexibility and fatigue failure, as well as providing specific strength and handling characteristics.

These mechanical properties have presented device makers with the opportunity to improve both patient comfort and surgeon handling, as well as treatment outcomes. Since the release of medical grade UHMWPE fibre in 2004, various device makers have collaborated with fibre developers that are producing a biocompatible UHMWPE fibre according to ISO13485 standard, to examine ways of translating the mechanical benefits into clinical benefits for patients. The fibre's record in some applications is outstanding. As a result of its strength and flexibility, medical grade UHMWPE fibre is now used in millions of patients and is the gold standard for orthopaedic high strength sutures.

While steel will remain the material of choice for many applications - those, for example, where fusion is critical and movement is a risk - UHMWPE fibre represents an exciting add-on to steel to those designers and engineers focused on advancing other device and treatment capabilities. The fibre offers massive innovation potential, especially as a result of the design freedom it offers: the fibres can be processed into linear or 2D/3D constructions including very thin wires, (flat) cables, tubes and sheets of any shape and size.



Graph illustrating the ultimate breaking strength of various materials.

Stronger than steel

UHMWPE fibres, at similar weight, are up to 15 times stronger than steel. But also at similar volume, the fibre is about four times stronger than titanium and polyester. Its exceptionally high tensile strength of close to 4GPa is enabling medical device manufacturers to design smaller, lower-profile implants for minimally invasive surgical procedures without sacrificing strength and durability. As such, medical-grade UHMWPE fibres offer designers one of the most promising means for realising the benefits associated with minimally invasive implants and techniques including shorter recuperation times and less scarring.

Superior fatigue resistance

The growing population of baby boomers that want to maintain active lifestyles despite hip, knee and spine conditions is fuelling skyrocketing demand for dynamic stabilisation procedures that relieve lower back pain without the loss of motion inherent in traditional spinal fusion techniques. Constructions made with UHMWPE fibres are more flexible and more resistant to fatigue failure compared to steel when subjected to cyclic or fluctuating loads. As such, spinal therapies using this technology are showing tremendous potential to enable preservation of mobility as well as fixation. This combination of

properties opens up a number of opportunities for device manufacturers to improve spinal surgical techniques and devices to meet the needs of this fast-growing demographic.

Better for fragile bones

Another area where UHMWPE fibres are helping the medical community to move beyond steel's limitations is in the treatment of soft, osteoporotic or cartilaginous bone. Over the last decade interest has grown significantly in identifying the ways this can translate into clinical benefits for the elderly, young or other patients with brittle bones. Metal cables have a narrow contact surface and hence show high focal loads. Focal loads can cause metal cables to cut through bone. However, polyethylene cables flatten when placed under tension, making them potentially more desirable in therapies for patients with fragile bones.

Safer for patients and surgeons

Because it has a low coefficient of friction, UHMWPE fibre slides easily through tissue. In instances where surgeons are navigating through challenging areas - narrow openings or around nerves - this softness and navigability has the potential to reduce the damage that could occur with a tougher or sharper cable such as those constructed with steel.

UHMWPE also has the potential to be safer for surgeons. Steel wires are sharp, and orthopaedic surgeries in particular can require surgeons to exert significant force during a procedure - surgeons have been known to cut themselves on sharp edges of steel cables. Steel typically maintains its shape, whereas the medical grade UHMWPE fibre has the softness of textiles, which is appreciated by surgeons. This contributes to a reduced potential for cutting, without compromising any strength in the device. As such, many surgeons find the material far easier and more comfortable to work with.

While steel is and will remain a primary material for device design, the material benefits of medical grade UHMWPE fibres are just a few of the reasons that growing numbers of device designers and engineers are turning to medical grade UHMWPE fibres constructions in increasing numbers. The new advances in the fibre are bringing designers closer to achieving their goals of improving the performing of existing devices, innovating entirely new devices and, most significantly, improving the lives of both patients and surgeons.

● www.dyneemapurity.com

SEM picture of UHMWPE fibre filament stretched over the sharp edge of a razorblade, demonstrating the increased contact surface and high compliance.