Ribbond vs. Glass Fiber Reinforcements

The term "strength" is commonly misunderstood in dentistry. There are many categories and qualities that together make up what is called strength. Manufacturers frequently use a single quality of strength (such as flexural modulus) to imply a material's clinical effectiveness. Unfortunately, a material that might be strong in one category might be extremely weak in another strength category that ultimately leads to its failure.

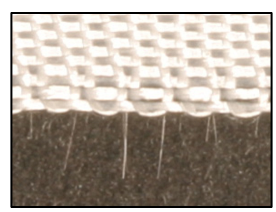
There are numerous factors that determine the effectiveness of a fiber reinforcement. Perhaps the three most influential factors are fracture toughness of the fibers, fiber configuration and manageability.

Fibers:
The same ultra-high molecular weight polyethylene fibers (UHMWP) used to make Ribbond are also used for making bulletproof vests. UHMWP fibers are extremely fracture-tough and damage tolerant.

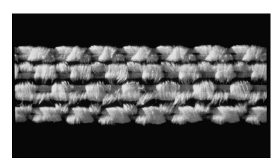
Glass fibers are strong, and have a high flexural modulus. However, because glass fibers are brittle and not fracture-tough, they are not used for making bulletproof vests.

Stress concentrations:
When cutting a plane of glass, a metal instrument is used to make a scratch in the surface of the glass. When the glass is scratched, stress concentrations develop at the scratch and the glass breaks at this imperfection.

When bent, this same phenomenon occurs with glass fiber reinforcements. In fact, woven glass fibers can break simply in the manufacturing process due to these stress concentrations. Fiber Splint by Polydentia is a plain weave, which means that the fibers are bent at sharp angles and therefore are "pre-weakened" at these bends prior to use. Broken fibers are visible in magnified photographs.

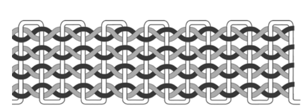


Ribbond's UHMWP fibers are not stiff and brittle like glass fibers and do not weaken due to stress concentrations. Because of these attributes, the Ribbond fibers can be bent to sharp angles and woven to make tight mechanical inter-locking from one thread to the next. As demonstrated in the magnified photograph, Ribbond's polyethylene fibers do not weaken from stress concentrations and do not break when woven and bent.



Ribbond's patented cross-link lock-stitch leno weave:
The fiber configuration significantly effects the long-term behavior of the reinforcement. Since dental structures must endure multi-directional forces, fiber configuration is clinically significant.

Ribbond is woven using a patented lock-stitch leno weave. Each inter-connection of one thread to the next forms a miniature knot. This prevents slippage of the fibers within the resin matrix and



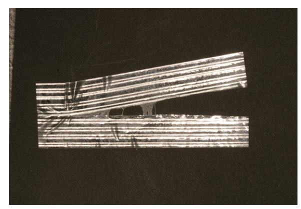
prevents micro-cracks from propagating to form larger cracks that lead to fracture failure. This also reinforces the prosthesis in multiple directions.

Unidirectional fibers:
Since glass fibers weaken when bent some manufacturers use glass fibers in a unidirectional orientation.

Unidirectional orientated fibers provide higher test results than woven fibers in the three-point load tests commonly used in the dental industry. However, these tests only stress a test-bar in one direction. In the case of unidirectional fibers, this type of test only applies force parallel to the direction of the fibers.

Since clinical structures will be subjected to multidirectional forces, a reinforcement should resist forces in multiple directions. There are two modes of failure for unidirectional glass fibers. One is that the brittle glass fibers break. The other mode of failure is fracturing of the resin matrix between the fibers. Fracture of the resin matrix occurs when the prosthesis is subjected to multidirectional forces. However, three-point load tests only stress the structure in one direction. Therefore these tests are not clinically relevant.

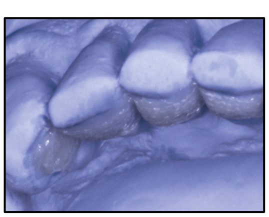
The behavior of unidirectional strapping tape describes this phenomenon very well. This tape is strong when forces are applied in the direction of the fibers. However, when forces are applied perpendicular to the fibers, the tape easily rips between the fibers. Ribbond's interlocking multidirectional configuration prevents this type of failure.



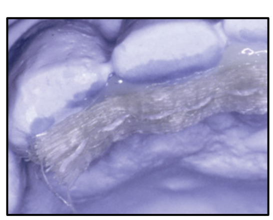
Manageability:
Manageability is an important factor in determining accurate and predictable placement of the material. Perhaps the most obvious difference between Ribbond and the competition is manageability. Unidirectional glass fibers have significant memory and are difficult to adapt to the teeth without "rebounding" back to its natural "straight" position. This makes adaptation difficult.

Ribbond has virtually no memory and does not unravel when adapted to the teeth. Accurate placement of the fibers is essential for maximizing the effectiveness of the "laminate effect" of the prosthesis.

Laminate design:
The design of a structure is equally important as the materials used to make the structure. The use of fibers reinforcements in dentistry is a derivative of the same fiber-composite-laminate science used in high-tech industry to make airplane tails, tennis rackets and boat hulls. The term laminate refers to layers and the closer the fibers are layered against the surfaces of the teeth the more effective the laminate effect. Accurate placement of the fibers is essential for maximizing the effectiveness of the "laminate effect" of the prosthesis. Therefore, the more manageable the fibers, the better the laminate results.



Ribbond can be adapted within the interproximal contacts.



Glass fibers do not adapt into interproximal contacts.

Note: Bonding the fibers within the interproximal contacts maximizes the laminate effect but results in a sharp bend of the fibers. If glass fibers could be bent and placed within the interproximal contacts, the sharp bend in the glass fibers would create severe stress concentrations. This sharp bend does not compromise the fracture-toughness of the Ribbond polyethylene fibers.

Durability and longevity:
There is no better test than the test of time. Ribbond continues to lead the field in its independently documented history of success and is the only fiber reinforcement with independently conducted clinical recall studies. Such studies include Howard E. Strassler (University of Maryland, *Compendium*, August 2001) recall study in which there were no fracture failures in the eleven periodontal splints followed for 46 to 84 months.

Clinical structures must endure multidirectional forces over a long period of time. Continuous use and fatigue will lead to the creation of cracks in the resin. Ribbond was designed for clinical success. Ribbond's unique combination of UHMWP fibers and patented leno weave make Ribbond the most durable and fracture-tough fiber reinforcement available to the dental industry.

Biocompatibilty:
When working with glass fibers in industry it is common practice to wear a respirator. Glass fibers are generally not considered biocompatible. The same polyethylene material used to make Ribbond's fibers is used to make liners for artificial hip and knee joints. This material is the standard in biocompatibility.

Polishing fibers:
Some representatives of glass fibers state that you can polish glass fibers and that Ribbond cannot be polished. This is partially true. Since Ribbond's fibers are so tough they cannot be cut at the same level as the composite with a burr and will therefore be "fuzzy" if polished. However, Ribbond's fibers are biocompatible. Glass fibers are not considered biocompatible. In industry, the use of glass fibers usually requires respirators for protection.

Being brittle, the glass fibers can be cut at the same level of the resin with a burr. However, if cut with a burr, as the resin wears away over time the glass fibers will not wear at the same rate. This will result in sharp protruding fibers that will cause irritation to the soft tissue. For different reasons, neither fiber can be polished.

Documented history:
Ribbond leads the field in its independently documented history of success (see *Reality* evaluation). There is no test more meaningful than the test of time.