2003

Engineering a High-Strength 2 mm Hybrid Biomedical Tape for Soft Tissue Fixation

Summary

A medical device OEM required the development of a narrow-profile biomedical tape capable of delivering high tensile performance, dimensional stability, and repeatable manufacturability within a controlled braided architecture.

The project focused on engineering a 2 mm hybrid tape structure combining polyester fibers with ultra-high molecular weight polyethylene (UHMWPE) reinforcement fibers. The development required precise optimization of braid geometry, carrier loading, core configuration, and machine process parameters to maintain dimensional consistency while balancing handling performance, structural stability, and manufacturing repeatability.

Through iterative braid development and process optimization, the program successfully established a scalable hybrid textile construction suitable for demanding soft tissue fixation applications.

The Challenge

Developing a stable 2 mm biomedical tape presented several engineering challenges due to the differing mechanical behaviors of polyester and UHMWPE fibers.

While UHMWPE fibers provided exceptional tensile strength and abrasion resistance, their low elongation characteristics introduced increased sensitivity to tension management and braid compaction during manufacturing.

Maintaining a consistent tape profile while preventing structural distortion required careful balancing of braid density, fiber loading, and core support.

Additional development challenges included:

- Maintaining tape flatness throughout processing
- Controlling braid compaction and edge stability
- Preventing structural distortion during haul-off
- Achieving repeatable splice geometry
- Maintaining dimensional consistency following coating processes
- Supporting scalable and repeatable production conditions

The development required a tightly controlled braid architecture capable of balancing both structural performance and manufacturability.

Engineering Objectives

The primary technical objectives included:

- Develop a stable 2 mm flat tape configuration
- Integrate high-strength UHMWPE reinforcement fibers
- Maintain dimensional consistency during braiding and downstream processing
- Improve load distribution through a flat tape architecture
- Achieve repeatable splice geometry and manufacturing performance
- Optimize braid stability and process repeatability for scalable production

Development Approach

Hybrid Braid Construction

The engineering approach centered on the development of a hybrid braided tape structure using polyester and UHMWPE fibers within a controlled cover/core configuration.

The final construction incorporated:

- Polyester cover elements to support handling characteristics and structural balance
- UHMWPE reinforcement fibers to improve tensile performance and abrasion resistance
- A twisted UHMWPE core combined with nylon monofilament to improve dimensional stability during braiding and downstream processing

Braid Architecture Optimization

The braid structure was refined through controlled optimization of:

- Alternating carrier loading arrangements
- Braid angle management
- Core support configuration
- Machine gear settings
- Haul-off conditions

Key process parameters included:

- 50 × 40 gear configuration
- 65 mm haul-off settings
- Controlled carrier loading symmetry
- Standardized splice configurations

Additional process development focused on maintaining tape flatness, width consistency, and braid symmetry throughout production.

Process Optimization & Repeatability

Achieving repeatable manufacturing performance required close control of both machine setup and fiber behavior throughout the braiding process.

Process consistency was maintained through controlled management of:

- Carrier loading configuration
- Fiber tension
- Core twist orientation
- Haul-off settings
- Coating application parameters

Alternating carrier loading arrangements were standardized to improve braid symmetry and width stability across production runs.

Machine setup parameters were additionally refined to produce:

- 38-inch splice lengths
- 12-inch overlap sections at both ends

Final inspection procedures verified:

- Structural consistency
- Width uniformity
- Mechanical repeatability
- Splice accuracy
- Visual braid quality

These controls supported scalable and repeatable tape manufacturing performance.

Validation & Performance Assessment

The braid construction was evaluated against defined dimensional and mechanical requirements to confirm process stability and structural consistency.

Validation activities included:

- Width verification
- Break load testing
- Extension analysis
- Diameter inspection

- Picks-per-inch (PPI) verification
- Splice configuration assessment

Testing confirmed the ability to manufacture the tape structure with repeatable geometry and controlled mechanical performance within the targeted dimensional profile.

Engineering Outcome

The project successfully demonstrated the feasibility of producing a high-strength 2 mm biomedical tape using a hybrid Polyester–UHMWPE braided construction.

Key engineering outcomes included:

- Development of a stable 2 mm flat tape configuration
- Successful integration of UHMWPE reinforcement fibers
- Controlled tape geometry and braid stability
- Improved load distribution through flat tape architecture
- Repeatable manufacturing performance
- Expanded capability in hybrid braid engineering

The development also established a technical foundation for future high-performance braided medical textile platforms requiring precise structural control and scalable manufacturability.

Application Relevance

Orthopedics & Sports Medicine

The hybrid Polyester–UHMWPE tape construction is well suited for high-strength soft tissue fixation applications where load distribution, abrasion resistance, and dimensional stability are critical. Potential applications include:

- Rotator cuff repair, ligament reconstruction, tendon fixation systems, suture anchor augmentation, soft tissue reinforcement tapes

Soft Tissue Repair & General Surgery

The flat braided tape architecture may additionally support applications requiring broader tissue contact and controlled load distribution, including:

- Soft tissue approximation, reinforcement structures, high-strength closure systems, general surgical fixation assemblies

Advanced Implants & Tissue Technologies

The project also demonstrated capability in engineered textile structures for:

- Implant reinforcement components, load-sharing textile assemblies, custom braided medical textile platforms

Key Takeaways

- Hybrid braid construction enabled a balance of strength, dimensional control, and manufacturability.
- Controlled carrier loading and braid geometry optimization improved tape stability and repeatability.
- UHMWPE reinforcement fibers provided enhanced tensile performance within a narrow-profile architecture.
- Process optimization supported scalable manufacturing capability for advanced biomedical textile applications.
- The project expanded expertise in high-performance braided medical textile development.

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