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Evaluating Silk as an Alternative to Polyester in High-Strength UHMWPE Braided Constructs

Executive Summary

UHMWPE-based braided structures are widely used in high-performance surgical applications due to their exceptional tensile strength, low elongation, and mechanical reliability.

This development programme explored whether targeted material substitution could modify handling behaviour while preserving the established performance characteristics of a high-strength UHMWPE braid.

Rather than redesigning the structure, the study replaced polyester with silk within an existing co-braid architecture to isolate the influence of material selection on mechanical performance, manufacturability, and handling characteristics.

The programme demonstrated that controlled material substitution can provide meaningful performance differentiation while maintaining structural consistency and production feasibility.

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The Challenge

Material substitution within established braided architectures introduces challenges that extend beyond replacing one fibre with another.

Although silk offers distinct handling and surface characteristics, its behaviour differs significantly from synthetic fibres and can introduce variability in both manufacturing and final performance.

Key engineering challenges included:

- Preserving tensile performance associated with UHMWPE systems
- Maintaining braid integrity with a softer cover material
- Managing variability introduced by natural fibres
- Maintaining structural consistency throughout processing
- Achieving reliable coating performance across different surface properties
- Preventing disruption to established manufacturing workflows

The objective was to introduce material-driven differentiation without requiring structural redesign.

Engineering Objectives

The programme focused on:

- Replacing polyester with silk within an existing braid platform
- Maintaining equivalent braid architecture for controlled comparison
- Evaluating effects on strength and flexibility
- Preserving manufacturing compatibility
- Supporting downstream coating and finishing operations
- Establishing repeatable production conditions

Development Approach

Material Substitution Strategy

The engineering approach isolated fibre selection as the primary development variable.

Key activities included:

- Substitution of polyester with silk within an established co-braid structure
- Retention of braid geometry and construction parameters
- Evaluation of fibre-to-fibre interaction and structural behaviour
- Verification of compatibility with MED2174 coating processes

Maintaining architecture consistency ensured that observed changes could be attributed to material behaviour rather than construction effects.

Manufacturing Process

The manufacturing route followed a standard braided suture workflow with targeted adaptation for silk processing characteristics.

Key stages included:

Yarn Preparation:

- Controlled loading and preparation of silk yarn

Braiding

- Formation of the braid under controlled carrier conditions

Finishing

- Discharge/logwood dyeing and controlled winding

Coating

- Application of MED2174 coating to support handling performance

Final Inspection

- Dimensional and structural verification

Process conditions were refined to accommodate differences in fibre friction and compliance.

Validation & Performance Assessment

Validation focused on understanding the effect of material substitution while preserving expected UHMWPE performance behaviour.

Assessment included:

- Break load evaluation
- Runnage and dimensional consistency
- Handling and flexibility assessment
- Knot behaviour evaluation
- Structural uniformity analysis

Testing demonstrated that performance expectations could be maintained while introducing measurable changes in handling behaviour.

Process Control & Repeatability

Introducing natural fibres increased reliance on process discipline.

Key controls included:

- Carrier tension management
- Input material verification
- Standardised coating conditions
- Monitoring of braid geometry
- Structural inspection throughout production

These controls enabled repeatable output despite increased material variability.

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Engineering Outcome

The programme demonstrated that targeted material substitution can provide controlled performance differentiation without requiring redesign of the underlying architecture.

Key outcomes included:

- Preservation baseline mechanical performance
- Improved flexibility and handling characteristics
- Expanded capability in hybrid material development
- Increased understanding natural material development
- Increased understanding of natural versus synthetic fibre trade-offs
- Repeatable manufacturing capability under modified material conditions

The work established material substitution as a practical development strategy for tuning behaviour in high-performance braided systems.

Application Relevance

Cardiovascular

Braided structures requiring high strength combined with controlled handling

Orthopaedics & Sports Medicine

High-load fixation applications where flexibility and tensile reliability must coexist

Soft Tissue Repair & General Surgery

Braided constructs requiring balanced handling and knot performance

Surgical Sutures & Closure Systems

High-performance closure systems requiring controlled mechanical behaviour

Minimally Invasive & Robotic Surgery

Fine braided structures supporting improved manipulation and procedural control

Advanced Implants & Tissue Technologies

Hybrid textile platforms combining structural and functional advantages

Key Takeaways

- Material substitution can alter behaviour without changing architecture
- Natural fibres require tighter process control than synthetic alternatives
- Handling performance can be engineered independently of strength
- Repeatable manufacturing remains critical during material transition
- Controlled substitution expands design flexibility in braided systems

"Performance was preserved by keeping the architecture constant and using material substitution as the primary engineering variable."

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