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Core Pathways and Technical Practices for AI-ready Transformation of Fiber Data

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ABSTRACT

Data serves as the foundational asset for process optimization and performance prediction in fiber manufacturing. However, fiber production is characterized by high coupling, strong time-variance, and cross-dimensionality, leaving raw data in a "crude" state that is difficult for machine learning models to utilize directly. This report focuses on the AI-ready transformation of fiber data, introducing core methodologies across three dimensions: temporal logic, representation learning, and mechanistic constraints. To address process continuity issues arising from material flow, we introduce temporal correlation processing, achieving a chronological reconstruction of continuous processes through cross-stage alignment and dynamic window slicing. To resolve the integration challenges of multi-source heterogeneous data—including process parameters (numerical), batch records (textual), and equipment imagery (visual)—we have constructed a multidimensional feature space vectorization scheme, enabling the mathematical representation of heterogeneous data within a unified space. Furthermore, to prevent AI models from generating predictions that violate physical laws, we incorporate Physics-Informed governance during the data preprocessing stage. By establishing boundary validation combined with derived feature engineering, we ensure that AI models possess enhanced interpretability and robustness.

Through these three systematic transformations, scattered raw records evolve into high-quality, high-consistency, AI-grade datasets. This approach not only significantly shortens the R&D cycle for algorithms but also effectively improves the accuracy of AI in practical applications, such as fiber quality traceability and autonomous process parameter optimization.