AI-Enabled Materials Manufacturing and Characterization

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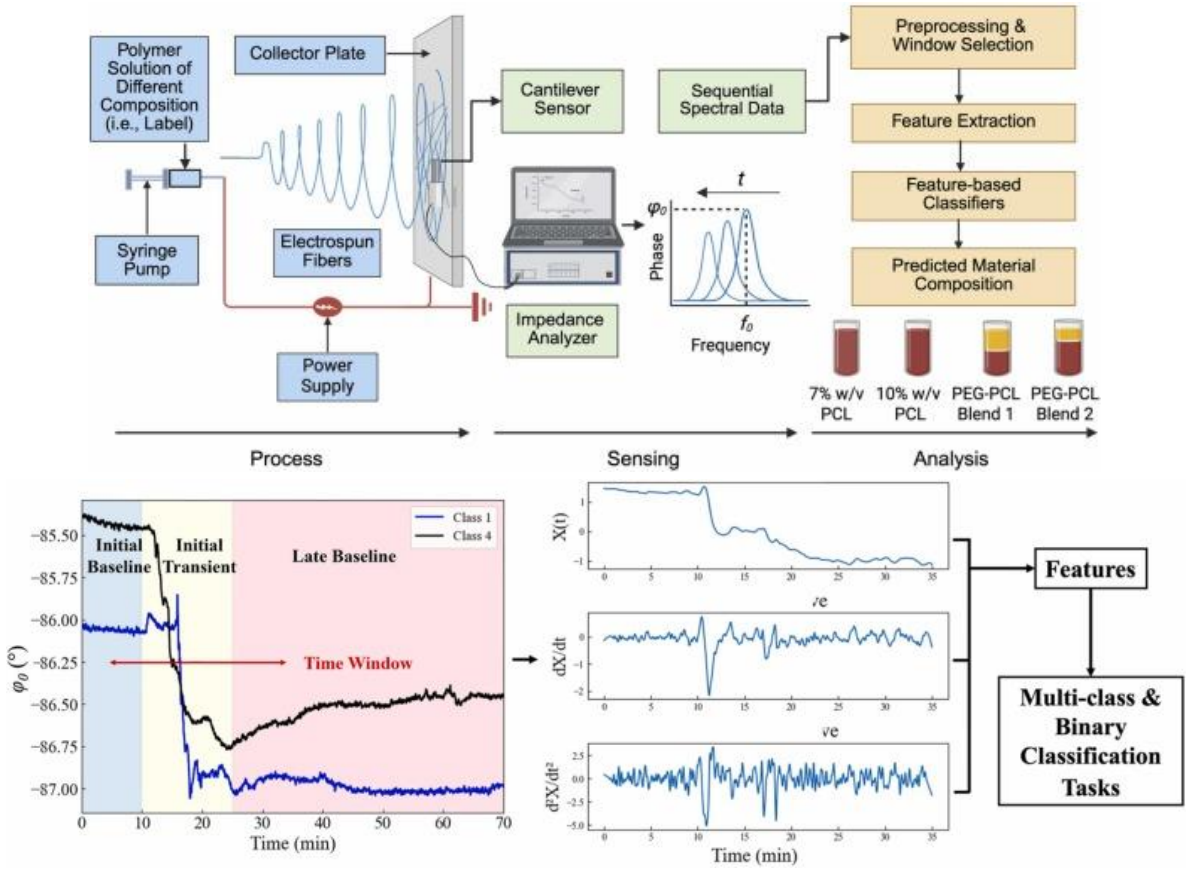
Manufacturing increasingly requires real-time process monitoring, automated characterization, and data-driven decision making. Through a series of in-house research projects, GlycoMIP developed capabilities for autonomous characterization, machine-learning-guided materials optimization, process-integrated sensing, and closed-loop manufacturing. By integrating these capabilities into data-driven materials development workflows, GlycoMIP enables accelerated materials innovation aligned with the Materials Genome Initiative.

In a recent study, GlycoMIP researchers and collaborators at Virginia Tech demonstrated that piezoelectric cantilever sensors integrated directly into electrospinning processes can generate rich dynamic signals that capture information about material composition in real time. By combining the early dynamic response of cantilever sensors with feature-based machine-learning analysis, the team accurately classified material composition during processing. The resulting framework translated manufacturing sensor responses into actionable information about material composition in real time, reducing reliance on conventional post-process analytical measurements.

This study demonstrates how process-integrated sensing and machine learning can support autonomous characterization and intelligent process monitoring. Such capabilities are essential for future closed-loop materials development and manufacturing systems.



Figures. Top: Process-integrated sensing combined with machine learning enables real-time monitoring of manufacturing processes and extraction of composition-related information from dynamic sensor responses. **Bottom:** Dynamic sensor-response data, including first- and second-derivative features, are analyzed using machine-learning models for material classification..