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RESEARCH ARTICLE

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# Optimization of solvent system for chitosan/polylactic acid/nanocellulose nanofibers using needleless electrospinning

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**Abstract**

Needless electrospinning (NES) is the most advanced and robust method to generate biopolymeric nanofibers. NES overcomes the needle clogging and low throughput issues of conventional needle based electrospinning (ES). However, the issue with all ES techniques is the absence of generalized methods in the literature, and most of the work is being done empirically. The solvent system dictates the feasibility of the ES process, and solvent system based studies can help create more generalized ES methods. The current work provides a systematic approach to fabricating tribiopolymeric nanofibers. NES was used to fabricate chitosan (CS)/polylactic acid (PLA)/nanocellulose (NCC) based nanofibers by optimizing the solvent system using dichloromethane (DCM) and trifluoroacetic acid (TFA). Biopolymeric blend PLA/CS/NCC (10:0.1:0.05 w/v %) in various formulated solvent systems were made and analyzed for their physical properties (sedimentation rate, particle size, viscosity, and surface tension) and subjected to NES. The binary solvent system SS91 (DCM (90):TFA (10) %) showed the lowest sedimentation rate and viscosity while the highest particle size and surface tension, resulting in the beads free nanofibers. The viscosity and surface tension comparison were used to determine a critical point for the feasibility of nanofiber fabrication. Overall, the study showed a systematic approach for fabricating complex tri-biopolymeric nanofibers in future.

**KEYWORDS**
biopolymers, nanofibers, needleless electrospinning, physical properties, solvent system

## 1 | INTRODUCTION

Electrospinning (ES) is a process for fabricating ultrafine fibers with sizes in the nanometer range.[1] The conventional needle ES process involves applying a strong electrostatic field to a polymer liquid (i.e., a solution or melt) from a fixed distance and at a constant flow rate.[2] When the electrostatic forces overcome the surface tension (ST), a taylor cone is formed, followed by fibers, which are collected using a grounded collector.[3] However, the main issue with conventional needle based electrospinning is the needle clogging and low throughput.[4] These issues are overcome by the advanced form of ES, needleless electrospinning (NES). This process involves using a wire to coat the polymer blend, and then numerous taylor cones are formed on the wire using the high voltage, and

  