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OPTIMIZATION OF MELT ELECTROWRITING (MEW) 3D BIOPRINTING PARAMETERS USING THE TAGUCHI METHOD

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3D bioprinting is a fabrication technique that allows obtaining scaffolds from different materials with the precisely controlled geometry and morphology. Biocompatible scaffolds produced by this method, with appropriate cells and adequate growth stimulants, have growing interest in tissue engineering. Melt electrowriting (MEW) is a specific, high-resolution bioprinting technique booming in recent years. In the MEW printer, the melted material in a metal nozzle is deposited on the collector, where high voltage is applied, with a computer-aided translating system. However, in order to create high-resolution layer-by-layer scaffolds, optimum values of parameters such as printing speed, air pressure applied for material flow, nozzle to collector distance, and the required voltage must be determined. Optimizing those values and understanding the relationship between the parameters are not trivial and consume significant amount of researchers' time. The traditional approach to determining the optimal parameters is based on trial-and-error: only one parameter is changed, and the other parameters are kept constant. However, such methods do not provide sufficient information about the interactive data between parameters, and require high number of attempts. Therefore, optimization studies using Design of Experiments (DoE) methodologies such as the Taguchi method are of great interest for determining the effects of parameters and optimum values. The Taguchi method is in the category of robust design, which simultaneously finds the optimum values of controllable factors and minimizes variation in uncontrollable factors.

In this study, optimizations of parameters such as collector voltage, nozzle temperature, air pressure, nozzle to collector distance, and writing speed used in the Bioscaffolder 3.3 MEW bioprinter were performed using Taguchi method (L16) experimental design (DoE) methodology. In the study, four different levels were used for each parameter. Results were evaluated in Minitab 20 software according to Nominal is Best-Signal to Noise ratios with ANOVA. It was shown that after correction testing, the optimal parameters, allowing to print high shape fidelity grid scaffold with approximately 350 µm interfiber distance were successfully determined. This study proves that the use of the Taguchi method can significantly support the application of the MEW approach in tissue engineering.