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ADVANCEMENT OF MATERIALS TO SUSTAINABLE & GREEN WORLD
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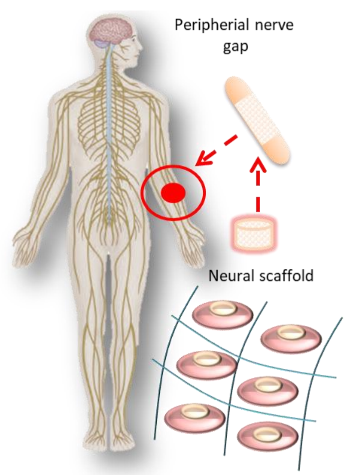
Smart Piezoelectric Scaffold for Nerve Regeneration

Angelika Zaszczyńska[1,]*, Paweł Sajkiewicz[1], Arkadiusz Gradys[1]

[1]Institute of Fundamental Technological Research Polish Academy of Sciences, Warsaw, 02-106, Poland

*Corresponding author: E-mail: angelika.zaszczynska@gmail.com

Graphical Abstract



Schematic representation of the application of tissue engineered nerve graft in repairing injured peripheral nerve.

Abstract

As regards the field of biomedical engineering, in recent decades, there may be observed an increasing scientific and technical interest in research related to the development of Smart Materials (SM). Such materials are generally designed to react in response to external stimuli (physical, chemical, mechanical), behaving similarly to natural body tissues. One important type of such SMs is a piezoelectric scaffold, which can generate electrical signals in response to the applied stress [**1,2**]. This research aims to efficiently support the re-growth and reconstruction of the diseased or damaged tissues by designing a three-dimensional smart scaffold, which is essential from the perspective of society in terms of treating spinal cord injuries, degenerative brain diseases, etc. The overall objective is devoted to designing and developing of a novel smart piezoelectric scaffold belonging to the type of conducting and stimuli-responsive scaffolds dedicated to neural engineering applications. The smart scaffold will significantly improve the effectiveness and safety of the medical nerve reconstruction procedures [**3,4**]

Polyvinylidene fluoride (PVDF, Mw = 530 000 g/mol) nanofibers were electrospun from 15% solution of dimethylformamide and acetone (DMF/Ac 4:1 weight ratio) at feed rate 0.2 mL/h (3 mm needle) and collected on drum collector (diameter 40 mm) at a distance between the needle and collector 180 mm. Human adipose-derived stromal cells (ADSCs) were cultured in osteogenic medium on the piezoelectric PVDF scaffolds electrospun with different collector rotational speed

(200, 1000 and 2000 rpm) and subjected to ultrasound stimulation (power 80 mW, frequency 1.7 MHz) for 30 minutes every 24 hours. ADSCs seeded on piezoelectric PVDF scaffolds without ultrasonic stimulation were used as a control for each group. In order to confirm the piezoelectric effect on ADSCs viability, PrestoBlue cell viability test was performed on day 3, 14 and 21. Results were statistically analyzed using the Student's t-test. The observations of fibres and cell morphology were conducted using Scanning Electron Microscopy (SEM), Fourier-transform Infrared Spectroscopy (FTIR) and Differential Scanning Calorimetry (DSC).

PVDF nonwovens as piezoelectric polymers stimulated by ultrasounds are advantageous for cells viability. The obtained preliminary results are promising from the perspective of tissue engineering applications.

Keywords: Piezo-nerve; scaffold, nanofibers; tissue engineering; stem cells.

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