

**Effective Parameters on conductivity of mineralized carbon nanofibers: An investigation using artificial neural network**

*Hadi Samadian<sup>1</sup>, Seyed Salman Zakariaee<sup>2</sup>, Mahdi Adabi<sup>1</sup>, Hamid Mobasheri<sup>3,4</sup>, Mahmoud Azami<sup>5</sup>, Reza Faridi-Majidi<sup>1\*</sup>*

<sup>1</sup> Department of Medical Nanotechnology, School of Advanced Technologies in Medicine, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Department of Medical Physics, School of Medicine, Ilam University of Medical Sciences, Ilam, Iran

<sup>3</sup> Laboratory of Membrane Biophysics and Macromolecules, Institute of Biochemistry and Biophysics, University of Tehran, Tehran, Iran

<sup>4</sup> Biomaterials Research Center (BRC), University of Tehran, Tehran, Iran

<sup>5</sup> Department of Tissue Engineering, School of Advanced Technologies in Medicine, Tehran University of Medical Sciences, Tehran, Iran

**Corresponding author e-mail:** [refaridi@sina.tums.ac.ir](mailto:refaridi@sina.tums.ac.ir)

Mean squared error (MSE), absolute average deviation (ADD) and standard error of prediction (SEP) were used to compare the predicted results with the measured values. The equations 1, 2 and 3 were used to calculate the MSE, AAD and SEP, respectively.

$$\text{MSE} = \frac{\sum_{i=1}^n (y_{i,m} - y_{i,p})^2}{n} \quad 1$$

$$\text{AAD} = \left\{ \frac{\sum_{i=1}^n \left( \frac{|y_{i,m} - y_{i,p}|}{y_{i,m}} \right)}{n} \right\} \times 100 \quad 2$$

$$\text{SEP} = \sqrt{\frac{\sum_{i=1}^n (y_{i,m} - y_{i,p})^2}{n}} \quad 3$$

Where 'n' is the number of experiments, 'y<sub>i,p</sub>' is the predicted value and 'y<sub>i,m</sub>' is the measured value.

Table 1. Mean squared error (MSE) of the ANN- based predicted currents for the training, validation, testing, and all input datasets.

Model	Train	Validation	Test	All
LM	0.0021	0.0111	0.0148	0.0062
BR-mode1	0.0053	0	0.0187	0.0067
BR-mode2	0.0066	0	0.0060	0.0065
SCG	0.0035	0.0075	0.0169	0.0061

Table 2. Absolute average deviation (AAD) of the ANN- based predicted currents for the training, validation, testing, and all input datasets.

Model	Train	Validation	Test	All
LM	1.1626	2.7568	3.0379	1.8248
BR-mode1	2.0828	0	4.8032	2.6599
BR-mode2	2.5370	0	1.8324	2.4877
SCG	1.4550	2.5345	3.8781	1.7739

Table 3. standard error of prediction (SEP) of the ANN- based predicted currents for the training, validation, testing, and all input datasets.

Model	Train	Validation	Test	All
LM	0.0462	0.1056	0.1154	0.0790
BR-mode1	0.0729	0	0.1877	0.0843
BR-mode2	0.0814	0	0.0775	0.0804
SCG	0.0591	0.0865	0.1299	0.0779

The comparison indicated that, for all input data, approximately equal MSE values were achieved by the different ANN models. The minimum MSE, SEP and ADD were respectively about 0.0061, 0.0779 and 1.7739 that were achieved for the SCG model.