ELECTRONIC TATTOOS FOR HEALTH TRACKING BASED ON GRAPHENE OXIDE

A. Lipovka[1], G. Murastov[1], O. Nozdrina[1], E. Sheremet[1], O. Kanoun[2], A. Al-Hamry[2], V. Prakash[3], S. Mehta[3]
Scientific adviser: professor, PhD R. Rodriguez*
[1]Tomsk Polytechnic University, Russia, Tomsk, Lenina av., 30, 634050
[2]Chemnitz University of Technology, Germany, Chemnitz, Straße der Nationen 62, 09111
[3]Institute of Forensic Science & Criminology, Panjab University, India, Chandigarh, Sector 14, 160014
E-mail: lipovka.a@gmail.com
*raulmet@gmail.com

Keywords: electronic tattoo, skin electronics, sensor, graphene oxide, flexible electronics, wearable electronics.

Introduction: According to the Forbes analysis [1], the healthcare Internet of Things market segment is poised to hit $117 billion by 2020. Sensor applications are significantly increasing and eHealth is the priority direction [2] for research. Wearable devices based on graphene are competitive and useful due to their thickness, softness, intimate connection with a skin without additional environment (such as the special gel for flat electrodes nowadays). Theoretical analysis affirms that only ultrathin and soft skin sensors can conform to skin morphology without additional adhesives [3, 4]. Described advantages are available due to the properties of graphene oxide: optical transparency, mechanical and chemical stability, biocompatibility. Suggested E-tattoos could be applied for several measurements, for example: ECG, EEG, EMG, temperature measurements. All these biometric sensors could be potentially used in the ambulatory treatment and health tracking markets. The first main stage for these devices production is the fabrication of the conductive circuits on different substrates. In the following paper some preliminary results are presented: experimental proof of the graphene oxide (GO) laser reduction possibility, optimization of the laser reduction parameters for glass substrate.

Materials and Methods. Graphene oxide solution by a modified Hummer's method. As the substrate, we used 0,17 mm thick glass cover slides. We chose the laser irradiation for GO reduction and direct writing the patterns as the chemically free and less complex method, which was produced by using ytterbium pulsed laser (Mini Marker) with the wavelength 1,064 µm. For the conductivity measurements, we used an Arduino-based ohmmeter.

Results and discussion. Graphene oxide is a non-conductive material due to the additional hydroxyl-contained groups in a structure, therefore, for conductive patterns fabrication it is necessary to provide the reduction and archive reduced graphene oxide (rGO) as the result. The results of the procedure strongly depend on the following laser parameters (table 1). The measured samples are illustrated on a figure 1.

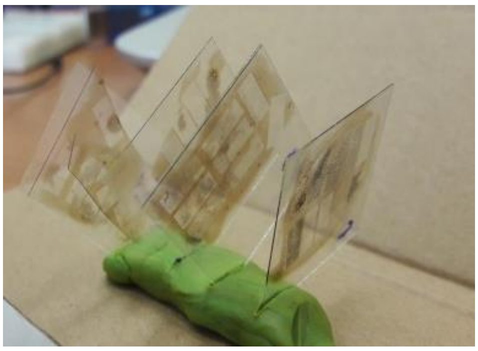

Fig.1. rGO samples

Table 1. Suitable parameters for GO reduction using laser irradiation

Parameter	Value	Units
Wavelength	1,064	µm
Pulse duration	50	ns
Frequency	90	kHz
Power	10	%
Writing speed	100	mm/s

Almost all of the samples showed significant changes in conductivity, measured by Arduino ohmmeter. Infrared laser is the best choice for the following purposes, because comparing to ultraviolet lasers it provides a bigger depth of penetration. We obtained that the laser power should not surpass 10 % of the nominal, in other way the material will be ablate completely. Taking into account all the parameters, writing speed is the less significant one. All the obtained parameters could vary for different substances. Also, the positive results depend on the thickness of the films and homogeneity of the layer.

Conclusion. Experimental data show us the principle possibility of the rGO patterns fabrication for the future application in the wearable tattoo-like sensors. The obtained results give us the suitable parameters to work with laser patterning at the future stages.

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