Abstract

Strain Sensor Based on Biological Nanomaterial †

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Abstract: We investigated a prototype of a strain sensor based on the layers of a bionanomaterial containing bovine serum albumin (BSA matrix) and multi-walled carbon nanotubes (MWCNT filler). The aqueous dispersion of 25 wt.% BSA/0.3 wt.% MWCNT was applied by screen printing onto flexible polyethylene terephthalate substrates. After drying the layers by laser irradiation (~970 nm), various parameters of the layers were controlled, i.e., resistance $R$, bending angle $\theta$, number of cycles $n$, and measurement time. One measurement cycle corresponded to a change within the range $\theta = \pm 150^\circ$. The layers of the BSA/MWCNT bionanomaterial had dimensions of $(15 \div 20) \, \text{mm} \times (8 \div 10) \, \text{mm} \times (0.5 \div 1.5) \, \mu\text{m}$. The dependences of resistance $R$ on the bending angle $\theta$ were similar for all layers at $\theta = \pm 30$, and the $R(\theta)$ curves represented approximate linear dependences (with an error of $\leq 10\%$); beyond this range, the dependences became nonlinear. The following quantitative values were obtained for the investigated strain sensor: specific conductivity $\sim 1 \div 10 \, \text{S/m}$, linear strain sensitivity $\sim 160$, and bending sensitivity $1.0 \div 1.5\%/\circ$. These results are high. The examined layers of the bionanomaterial BSA/MWCNT as a strain sensor are of particular interest for medical practice. In particular, strain sensors can be implemented by applying a water dispersion of nanomaterials to human skin using a 3D printer for monitoring movements (arms and blinking) and the detection of signs of pathology (dysphagia, respiratory diseases, angina, etc.).

Keywords: strain sensor; bovine serum albumin; multi-walled carbon nanotubes; laser irradiation; strain sensitivity


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