Nanostructured surfaces

Compositional material based on pyrolytic carbon and copper nanoparticles

V.I. Mandzyuk, I.F. Myronyuk, R.P. Lisovskyy, V.M. Sachko

Vasyl Stefanyk Precarpathian National University, Shevchenka Str., 57, Ivano-Frankivsk-76018, Ukraine. e-mail: mandzyuk_vova@rambler.ru

The paper studied the porous structure and electrical conductivity of the composite material obtained from pyrolytic carbon and $1 \div 10$ wt. % of copper nanoparticles. Disaccharide $C_{12}H_{22}O_{11}$ and $CuCl_2$ salt were used as a feedstock to produce a compositional material. The process of material obtaining included the dissolution of disaccharide and $CuCl_2$ in water, heating the solution at a temperature of $160 \div 180$°C for 0.5 h for the realization of carbohydrate precursor caramelization and reduction of Cu^{2+} ions to Cu^0 ones. Composite material carbonized at a temperature of $270 \div 300$°C further is annealed in protective atmosphere at 800°C for 0.5 h. The feature of carbonization stage is that all carbon atoms in disaccharide moving into solid phase and do not form volatile compounds with oxygen atoms.

Structural and morphological parameters of the composite material were measured by means of nitrogen adsorption / desorption isotherms at a temperature of 77 K with the automated sorptometer Quantachrome Autosorb (Nova 2200e). The electrical conductivity of the material was measured in amplitude-frequency analyzer Autolab/FRA-2 (Holland) in the frequency range of $10^{-3} \div 10^5$ Hz.

The parameters of material shown in Table 1 indicate that the increase in the content of copper nanoparticles in the composite leads to an increase in the mesopore volume (V_{meso}) and specific surface area of the material (S_{sp}). However, the presence of copper nanoparticles in the material leads to a significant decrease in its conductivity, which requires further researches.

Table 1

Conductive and morphologic parameters of compositional materials

Standard	σ, $Ohm^{-1} \cdot m^{-1}$	S_{sp}, m^2/g	S_{micro}, m^2/g	S_{meso}, m^2/g	V, cm^3/g	V_{micro}, cm^3/g	V_{meso}, cm^3/g	d_p, nm
C	42.5	135	85	50	0.083	0.037	0.046	2.5
C + 1 % Cu	$1.42 \cdot 10^{-3}$	221	132	89	0.147	0.055	0.092	2.7
C + 10 % Cu	$4.73 \cdot 10^{-3}$	318	198	120	0.185	0.071	0.114	2.3

The carbon-copper composite can be applied as an electrode material in electrochemical power sources.