6th ISE Satellite Student Regional Symposium on Electrochemistry

BOOK OF ABSTRACTS

Knjiga sažetaka

Zagreb, Croatia, 8th July 2016

Published by:

University of Zagreb, Faculty of Chemical Engineering and Technology

Organizing Committee:

Lara Čižmek

Jozefina Katić

Editor:

Jozefina Katić

Technical Editor:

Davor Antonić

ISE Regional Representative (Croatia):
Marijana Kraljić Roković

"6th ISE Satellite Regional Symposium on Electrochemistry" (ISE - SRSSE) is organized under the patronage of the International Society of Electrochemistry (ISE).

The professional and grammatical errors of the abstracts are authors' responsibility.

ISBN: 978-953-6470-73-0

CONDUCTIVE PATHWAYS IN ELECTROCONDUCTIVE BIODEGRADABLE POLYMER MATRIX COMPOSITES

Provodni putevi kod elektroprovodnih kompozita sa biodegredabilnom polimernom matricom

Marijana Pantović, Miroslav M. Pavlović, Jasmina Stevnović

University in Belgrade, ICTM-CEH, Njegoševa 12, Belgrade, Serbia

The results of experimental studies of the properties of composite materials based on lignocellulosic (LC) and poly(methylmetacrylate) matrices filled with electrolytic copper powder are presented. Volume fractions of metal fillers in composite materials and tested samples were varied in the range of 0.5-29.8% (v/v). Characterization included examination of the influence of particle size and morphology on the conductivity and percolation threshold of the composites using SEM and AFM. Presence of three dimensional conductive pathways was confirmed.

Electrolytic copper powder was deposited galvanostatically at current density of 3600 A/m^2. The electrolytes were prepared from technical chemicals and demineralized water. The deposition time (time of powder removal by brush) was 15 min. The apparent density of electrodeposited copper powder was 0.557 g/cm^3, and the results of quantitative microstructural analysis are shown in Table 1.

Table 1. The parameters which characterize sieved fraction (≤ 45μm) of electrolytic copper powder deposited galvanostatically at current density of 3600 A/m^2

	Max	Min	Mean
A (area) (μm^2)	1189.52	8.23	198.34
L_p (perimeter) (μm)	368.10	1.91	128.52
D_{max} (μm)	104.71	4.31	55.17
D_{min} (μm)	27.22	0.96	11.42
f_A (form area)	1.00	0.38	0.75
f_L (form perimeter)	0.86	0.13	0.52

The results of the obtained copper powder show that the powder has very high surface area. Powder shows very distinct features for highly dendritic particles with well developed primary and secondary dendrite arms with the angles between them typical for the face centered cubic crystals. This feature can be seen on Figure 1, which shows one copper powder particle obtained by constant current deposition. f_L and L_p values show that copper powder particles are not very compact and rounded, but have pronounced dendrite branching. Hence, this powder is good prerequisite for formation of more interparticle contacts between conductive copper particles and lowering the percolation threshold.

Figure 1. *SEM photomicrographs of copper powder particles obtained in constant current deposition.*

EDS measurements (Figure 2) show the existence of copper conductive pathways throughout the composites volumes. Due to the packaging effect and more pronounced interparticle contact with smaller, highly porous, highly dendritic particles with high values of specific area lead to "movement" of percolation threshold towards lower filler content. This feature can be observed on both on Figure 2 and Figure 3. Figure 3 presents AFM image of the PMMA and LC composite surfaces after breaking. These pathways are formed in 3D in a pure random order.

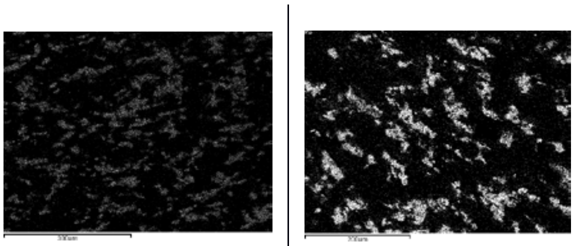

Figure 2. *EDS images of the composite sample prepared at percolation threshold. White dots represent Cu. (left) LC-Cu and (right) PMMA-Cu composite*

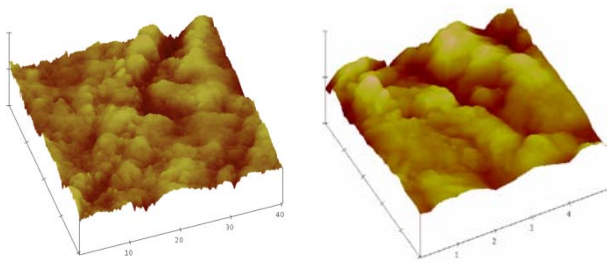

Figure 3. *3D AFM images of the PMMA (left) and LC (right) composite filled with copper powder at percolation threshold*

Conclusions

The results showed that the shape and morphology of the copper powder, and filler at all, play a significant role in the phenomenon of electrical conductivity of the prepared samples and the appearance percolation threshold. The particles with highly developed free surface and dendritic and highly branched structure, such as galvanostatically obtained copper powder particles can easier form interparticle contacts at lower filler volume fractions than particles with more regular surface.

When two different matrices are compared, slight advantage can be given to PMMA since the percolation threshold is at lower value. However, lignocellulose is biodegradable, green matrix, and it comes from abundant, sustainable resource, and it can be used for green composite production.

References

(1) V.V. Panić, R.M. Stevanović, V.M. Jovanović, A.B. Dekanski, *J. Pow. Sour.* **181** (2008) 186.

(2) M. M. Pavlović, M. G. Pavlović, V. Ćosović, V. Bojanić, N. D. Nikolić, R. Aleksić, *Int. J. Electrochem. Sci.* **9** (2014) 8355.