Nanocomposites and nanomaterials

New promising nanostructured porous materials based on conjugated polymers, obtained via template-assistant approach

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We report here new 3D nanostructured porous conjugated polymers (polyaniline – 3D PANI and poly-*m*-phenylenediamine – 3D PmPDA), which were obtained by means of oxidative polymerization of corresponding monomer in presence of mesoporous cellular foam (MCF [1]) as a hard template with subsequent removal of MCF from polymer by alkaline treatment. The identity of molecular structures of polymers obtained via template-assistant method and bulk polymerization was confirmed by means of FTIR spectroscopy and C,H,N-elemental analysis. TEM data indicate predominantly globular morphology for 3D PANI and fibrillar – for 3D PmPDA. Also, it is found, that 3D PANI and 3D PmPDA have higher surface area, if compare with polymers, that were prepared without MCF, which makes the use of such nanostructured conjugated polymers promising for various practical applications.

The same technology we apply to produce the nanocomposite Co-N-C-electrocatalyst for oxygen reduction reaction (ORR): (i) high-temperature treatment in inert atmosphere of mixture of *m*-phenylenediamine, oxidant (ammonium persulfate), $Co(NO_3)_2$, graphene oxide (obtained by means of modified Hummers method [2]), and MCF; (ii) removal of a template from a carbonized nanocomposite. It is found that Co-N-C-electrocatalysts, prepared both with and without MCF, possess sufficiently high activity in the ORR in acidic and alkaline solutions and are characterized by similar values of ORR onset potential. However, hybrid electrocatalyst, obtained by template-assistant carbonization provides higher currents in ORR (i.e. ensures greater efficiency in the electrochemical process) which may be due to higher surface area of such material.

1. *Schmidt-Winkel P., Lukens Jr. W.W., Zhao D., Yang P., Chmelka B.F., Stucky G.D.* Siliceous Mesostructured Cellular Foams with Uniformly Sized and Shaped Pores // Mat. Res. Soc. Symp. Proc.–1999.–**576**.–P. 241–246.
2. *Kovtyukhova N., Ollivier P., Martin B., Mallouk T., Chizhik S., Buzaneva E., Gorchinskiy A*. Layer-by-Layer Assembly of Ultrathin Composite Films from Micron-Sized Graphite Oxide Sheets and Polycations // Chem Mater.-1999.-**11**.-P. 771-778.