Nanocomposites and nanomaterials

The effect of adsorbed PMS-400 on the textural characteristics of the triple TiO_2–ZrO_2/SiO_2 nanooxides

I.Ya. Sulym[1], D. Sternik[2], M.V. Borysenko[1], A. Derylo-Marczewska[2]

[1] *Chuiko Institute of Surface Chemistry, NASU, 17 General Naumov Str., 03164 Kyiv, Ukraine.*
E-mail: sulim1981@mail.ru

[2] *Faculty of Chemistry, Maria Curie-Sklodowska University, M.C. Sklodowska Sq. 3, 20031 Lublin, Poland.*

The present work focuses on research of the textural and morphological properties of composites based on mixed TiO_2–ZrO_2/SiO_2 nanooxides and linear poly(dimethylsiloxane) (PMS-400). This study was performed using low temperature nitrogen adsorption/desorption, FTIR spectroscopy and SEM methods.

Silica-supported titania–zirconia nanocomposites (TiO_2–ZrO_2/SiO_2) were prepared using $Zr(acac)_4$ and $C_{10}H_{11}O_5Ti$ solutions in isopropyl alcohol (IPA) added to fumed silica (S_{BET} = 283.4 m^2/g) at 82.5 °C. The reaction mixture was stirred in a refluxing tube for 1 h. Then IPA and the acetylacetone reaction product were removed from the mixture by evacuation. The solid product was then dried and calcined at 550 °C for 1 h. The content of ZrO_2 was 10 wt. % and the contents of grafted TiO_2 was 3 and 10 wt. % (TZS1 and TZS2, respectively). PMS-400 fluid ($M_w \approx 5700$) was adsorbed onto oxide surfaces in amounts of 5 - 40 wt. %.

The reduction of S_{BET} is stronger for TZS/PMS at C_{PMS} = 5 wt. % in comparison to SiO_2/PMS systems. The pore volume (V_p) of the nanooxide/PMS composites decreases with increasing C_{PMS} (Table). SEM study showed changes in the outer surfaces of samples due to polymer adsorption.

Table. Textural characteristics of nanooxide/PMS-400 composites

Sample	S_{BET}, m^2/g	S_{mic}, m^2/g	S_{meso}, m^2/g	S_{macro}, m^2/g	V_{mic}, cm^3/g	V_{meso}, cm^3/g	V_{macro}, cm^3/g	V_p, cm^3/g	R_p, nm
SiO_2/P5	224.8	27.1	131.9	65.8	0.002	0.054	2.168	2.224	29
SiO_2/P40	73.9	2.2	49.6	22.1	0.000	0.027	0.925	0.952	36
TZS1/P5	208.3	36.3	105.2	66.8	0.028	0.745	0.478	1.251	41
TZS1/P40	67.9	10.9	39.2	17.8	0.005	0.229	0.286	0.520	27
TZS2/P5	204.3	29.0	138.0	37.3	0.014	0.352	0.645	1.011	21
TZS2/P40	57.0	2.5	48.1	6.4	0.000	0.058	0.202	0.26	23

Acknowledgments: The authors are grateful to European Community, Seventh Framework Programme (FP7/2007–2013), Marie Curie International Research Staff Exchange Scheme (IRSES grant No 612484) for financial support of this work. The research was partly carried out with the equipment purchased thanks to the financial support of the European Regional Development Fund in the framework of the Polish Innovation Economy Operational Program (contract no. POIG.02.01.00-06-024/09 Center of Functional Nanomaterials).