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PHYSICOCHEMICAL PROPERTIES OF TI-BASED MXENES OBTAINED FROM SHS SYNTHESIZED MAX PHASES AND THEIR APPLICATION FOR ENERGY STORAGE

Sergii A Sergiienko[1], **Vladislav A Kolotygin**[2] and **Nataliya D Shcherban**[3]
[1]National University of Science and Technology MISiS, Russia
[2]Institute of Solid State Physics RAS, Russia
[3]L V Pisarzhevskii Institute of Physical Chemistry, Ukraine

MXenes attract attention as electrodes for energy storage applications e.g. for supercapacitors due to combination of large theoretical electrochemically active surface; high theoretical conductivity; and hydrophilic nature of their surfaces. The problem is that the methods of MXenes preparation described in the literature are often multi stage and complicated. So the purpose of our work is the development of more simple and technologically acceptable method of MXenes preparation. In the literature the synthesis of MAX phases (precursors for MXenes synthesis) has been realized by different methods. So we used one stage self-propagating high-temperature synthesis (SHS) that seems most suitable because of this method has several advantages like simplicity; short reaction time; cost-effective; and little demand on external energy. For SHS commercially available Ti, Al and carbon black powders were used. Several phases (mainly Ti_3AlC_2, Ti_2AlC, TiC, Al_2O_3) were among the products after SHS. Obtained products are crushed in a roll crusher and then automatic agate mortar. For Al etching from the MAX phase a dilute solution of HF was used. Then delamination of MXenes in N,N-dimethylformamide and isopropanol mixture with sonication were lasted during three days. The content of unreacted MAX phase particles in MXene powder can be reduced by using hydrocyclone assembly and alcohol medium instead of water. Suspension stability of MAX phase particles decreases rapidly while suspension of MXene particles is fairly stable. Also alcohol medium can protect $Ti_3C_2T_x$ MXene from oxidation. Then MXene powder was washed with water several times and to remove residual water vacuum filter was used. Since both layered $Ti_3C_2T_x$ and Ti_2CTx obtained can be used as electrodes for super capacitors, SHS method is suitable for Tix+1AlCx phase preparation. In neutral aqueous electrolyte (1 M solution of Na_2SO_4) obtained electrodes demonstrated gravimetric capacitance up to 220 Fg^{-1} at charge-discharge rates 2 mVs^{-1}.

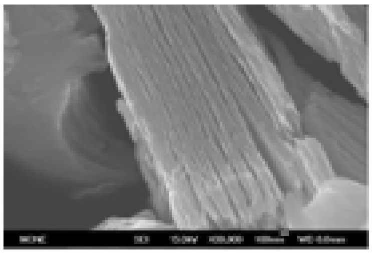

Figure 1: SEM images of Ti3C2 MXene

Recent Publications

1. S A Sergiienko, V A Kolotygin, N D Shcherban, S M Filonenko, D O Moskovskikh, A A Nepapushev, D I Arkhipov and O B Tursunov (2017) Structure and transport properties of the spark plasma sintered barium cerate based proton conductor. Ceramics International 43(17):14905-14914.
2. N D Shcherban, S M Filonenko, S A Sergiienko, P S Yaremov, M A Skoryk, V G Ilyin and D Yu Murzin (2018) Morphological features of porous silicon carbide obtained via a carbothermal method. International Journal of Applied Ceramic Technology 15(1):36-41.
3. N D Shcherban, S M Filonenko, R Yu Barakov, S A Sergiienko, Kai Yu, Ivo Heinmaa, A Ivaska and D Yu Murzin (2017) New insights in evaluation of acid sites in micro-mesoporous zeolitelike materials using potentiometric titration method. Applied Catalysis A: General 543:34–42.
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5. S Sergiienko, K Moor, K Gudun, Z Elemessova and

R Bukasov (2017) Nanoparticle-nanoparticle vs. nanoparticle-substrate hot spot contributions to SERS signal: studying Raman labeled monomers, dimers and trimmers. Physical Chemistry Chemical Physics 19:4478–4487.

Biography

Sergii A Sergiienko has ten years of working research experience at L V Pisarzhevskii Institute of Physical Chemistry of the National Academy of Sciences of Ukraine. His research projects mainly devoted to synthesis and investigation of functional properties of ordered porous materials. He has published 14 international research papers. His current research project deals with synthesis and characterization of novel nano-hetero-structured MXene-based materials for electrochemical energy storage at National University of Science and Technology MISiS, Russia.

s.sergienko@misis.ru