

**DEVELOPMENT OF COMPOSITES OF NICKEL NANOPARTICLES  
WITH ANODIC NANOPOROUS ALUMINA**

*Kurmach M. M.*<sup>1</sup>, Mishura A. M.<sup>1</sup>, Lytvynenko A. S.<sup>1</sup>, Brzózka A.<sup>2</sup>, Zaraska L.<sup>2</sup>

<sup>1</sup>L. V. Pisarzhevskii Institute of Physical Chemistry of the National Academy of Sciences of Ukraine, Prospekt Nauky, 31, Kyiv, 03028, Ukraine

<sup>2</sup>Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387 Kraków, Poland  
mazinator3710@ukr.net

Fine organic synthesis is an important field of chemical industry focusing on preparation of complicated organic substances in gram-scale amounts. A family of reactions crucial for this is catalyzed with compounds or nanostructures of palladium, e.g. hydrogenation or C–C cross-coupling [1]. High cost and scarcity of Pd motivates the search of cheaper alternatives. Ni is one of the most prospective substituents, active in a number of the Pd-catalyzed reactions (e.g., [2]). Development of novel supports for Ni nanoparticles (NPs) is another prospective way to facilitate the target processes. It is especially attractive to develop supports that possess high specific surface and constitute a whole entity in order to avoid extra steps of separation of the reaction products from the catalyst.

The work aimed to develop methods of formation of novel nanocomposites by impregnation of nanosized Ni into anodic nanoporous alumina (AAO), elucidation of the influence of the impregnation conditions on the structure of the composites.

AAO samples were prepared following the two-step anodization procedures, reported previously by us [3]. AAO emerged as a thin (dozens of micrometers) layer on high purity Al plate. The layer possessed a system of quasi-cylindrical pores (dozens of nanometers in diameter) oriented normally to the surface and arranged in honeycomb-like structure (Fig. 1). Impregnation was achieved via treatment of AAO on Al plate with solutions of NiCl<sub>2</sub> in water and methanol. Treatment was performed by: (1) immersion of the plate into solution; (2) dropcasting of the solution onto AAO layer; (3) immersion into solution accompanied with ultrasonication. Then, Ni<sup>2+</sup> was reduced to Ni<sup>0</sup> by a solution of NaBH<sub>4</sub> in methanol.

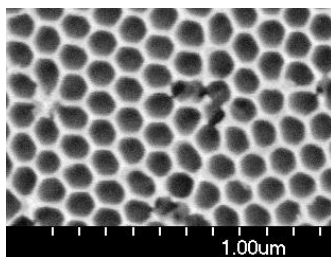


Fig. 1. SEM image of AAO sample

It was found that ultrasonic treatment in concentrated (over 0.1 mol/L) NiCl<sub>2</sub> solutions in methanol was crucial for ensuring even distribution of the impregnating NPs throughout the surface. Ni deposited as NPs (dozens of nanometers in diameter): (a) separated ones “plugging” the pores or (b) as aggregates on the outer surface.

*The work was supported by a joint Polish-Ukrainian grant co-funded by the Ministry of Education and Science of Ukraine (contract No M/115-2020) and the Polish National Agency for Academic Exchange (contract No PPN/BUA/2019/1/00034/U/00001).*

1. Chem. Rev., 2011, 111, 3, 2251–2320.
2. Inorg. Chem. Commun., 2020, 121, 108203.
3. Electrochim. Acta, 2016, 198, 259–267.