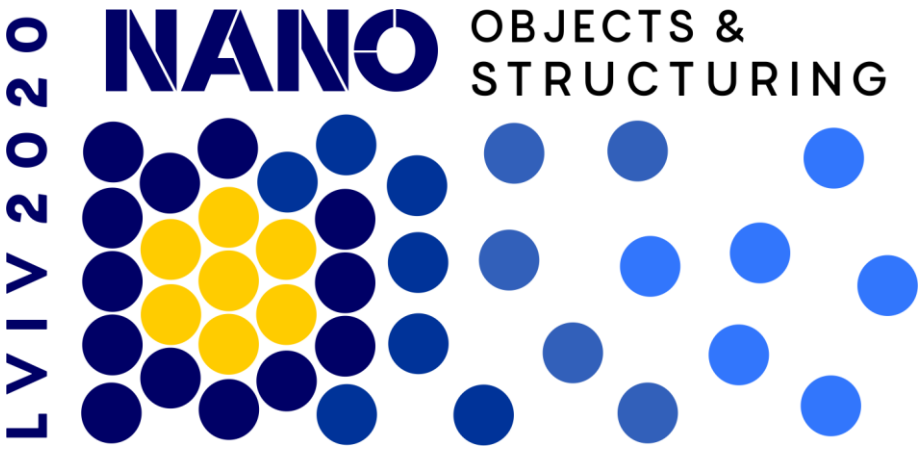
Ministry of Education and Science of Ukraine

Ivan Franko National University of Lviv

Faculty of Chemistry

Shevchenko Scientific Society

The National Academy of Sciences of Ukraine



I[st] INTERNATIONAL RESEARCH and PRACTICE CONFERENCE «NANOOBJECTS & NANOSTRUCTURING» (N&N–2020)

September 20–23, 2020, Lviv, Ukraine

BOOK of ABSTRACTS

Ni-BASED NANOPOWDERS AS CATALYSTS OF $NaBH_4$ HYDROLYSIS

Kytsya A.[1,2], Berezovets V.[1], Bazylyak L.[2], Verbovytskyy Yu.[1], Kos O.[1]

[1] Physico-Mechanical Institute NAS of Ukraine, Naukova Str., 5, Lviv, Ukraine.
[2] Department of Physical Chemistry of Fossil Fuels InPOCCC NAS of Ukraine, Naukova Str., 3a, Lviv, Ukraine.
berezovets@gmail.com

Hydrolysis of sodium borohydride is the promising reaction of hydrogen production for utilizing in the portable energy supply systems. At the same time both the storage of $NaBH_4$ and hydrolysis reaction must be carried out in strong alkaline solutions due to (i) prevent spontaneous hydrolysis in neutral medium and (ii) prevent the formation of boranes which may deactivate catalytic surface of power fuel cell [1]. At the same time the reaction rate of hydrolysis in alkaline medium is very low and for accelerating of the process different metal based (both noble and base metals, often Ni, Co, Pt, Pd) heterogeneous catalysts are used. In recent investigations the attention of researchers is devoted to utilizing of mono and bimetallic nanoparticles as catalysts of hydrolysis reactions. The one of the groups of promising catalysts are nickel and nickel-based nanostructures due to perfect combination of low cost and high efficiency [2]. That is why herein we present results of investigations of a range of Ni-based of nanostructures (NS) as catalysts for $NaBH_4$ hydrolysis in alkaline media.

Ni-based nanopowders (Raney Nickel (Ni-R); 160±40 nm Ni nanoparticles; 40±20 nm $Ni_{75}Cu_{25}$ statistical nanoalloy; Ni@Ag nanostructure) were synthesized as were reported earlier [3, 4] and characteristics of the corresponding nanoparticles are presented in Table 1. Hydrolysis reactions were carried out at the 20 °C, initial concentration of $NaBH_4$ was 1 mol/L, concentration of NS and pH were varied at the ranges 5 … 20 10 mg/L and 11 … 12 respectively. Hydrogen evolution rate was measured by automated volumetric setup. The first order rate constants were evaluated by linear segments of the kinetic curves.

Table 1. Rate constants of $NaBH_4$ hydrolysis in the presence of nanocatalysts

NS	Concentration, mg/mL	pH	k_{H2}, min^{-1}
Ni-R	10	11	2×10^{-4}
$Ni_{75}Cu_{25}$			1.8×10^{-3}
Ni@Ag			4.3×10^{-3}
NiNPs			5.5×10^{-3}
NiNPs	5	12	2.5×10^{-3}
NiNPs	10		3.6×10^{-3}
NiNPs	20		7.4×10^{-3}

It was found that the higher catalytic activity possess NiNPs. At the same time it was observed low dependence of the rate constant of hydrolysis reaction in the presence of NiNPs on pH that may indicate the Horiuti-Polanui-like mechanism of catalysis.

This work was carried out with the financial support of the NATO project G5233 "Portable energy supply".

1. B. H. Liu, Z. P. Li. A review: hydrogen generation from borohydride hydrolysis reaction // J. Power Sources. –2009. – 187(2). – P. 527–534.
2. S. A. Al-Thabaiti, Z. Khan, M. A. Malik. Bimetallic Ag-Ni nanoparticles as an effective catalyst for hydrogen generation from hydrolysis of sodium borohydride // Int. J. Hydrogen Energy. – 2019. – 44(31). – P. 16452–16466.
3. I. Y. Zavaliy, A. R. Kytsya, Y. V. Verbovytskyy, Y. O. Kulyk, P. Y. Zavalij. Synthesis and Structure of Ni-Based Nanopowders // 2018 IEEE 8th International Conference Nanomaterials: Application & Properties (NAP). https://doi.org/10.1109/NAP.2018.8914926
4. A. Kytsya, L. Bazylyak, O. Pobigun-Halaiska, I. Opeida, P. Simon, I. Zelenina. Synthesis and Catalytic Properties of Ni@Ag Bimetallic Nanostructures // In 2018 IEEE 8th International Conference Nanomaterials: Application & Properties. https://doi.org/10.1109/NAP.2018.8915129