National Technical University
"Kharkiv Polytechnic Institute"

PROPOSAL

for Scientific Cooperation

of Physical Chemistry Department

WE INVITE YOU
FOR SCIENTIFIC COOPERATION

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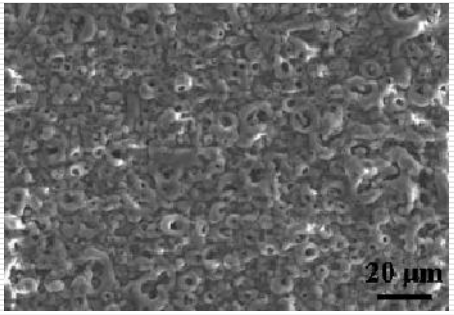
Main stream of research: **Electrochemical Design of Functional Materials and Coatings**

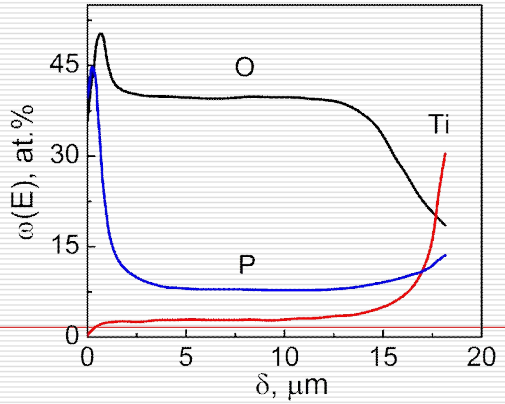
- **Plasma electrolytic oxidation (PEO) of Aluminum and Titanium alloys for mixed oxide coatings synthesis**
- **Electrochemical synthesis of composite coatings based on metallic matrix reinforced by nanoscale oxides (Al_2O_3, ZrO_2, TiO_2)**
- **Electrodeposition of multicomponent alloy coatings**
- **Smart materials – Synthesis and Applications**
- **Corrosion monitoring and prediction of protective coatings service life**

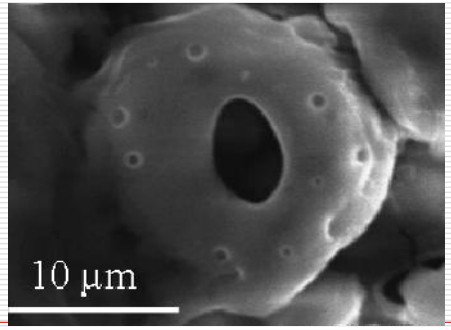
Mixed PEO coatings synthesis on Aluminum and Titanium alloys

- PEO of aluminum and titanium alloys for one step synthesis mixed oxide coatings containing p,d-elements (Co, Mn, Fe, Ni, Zn, Sn), refractory and rare metals (W, Mo, Zr, V) with wide range of functional properties – high corrosion resistance and chemical stability, high wear resistance, low coefficient of friction, heat resistance, catalytic activity in combustion and wastes purification processes, adjustable porosity, biocompatibility

Ti/TiO$_x$

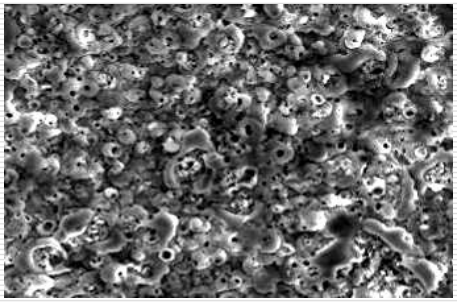




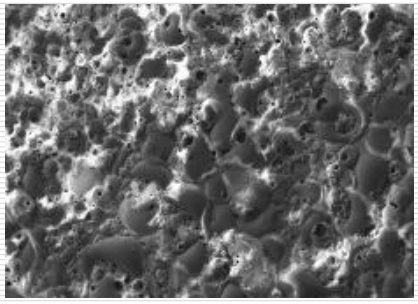


Titanium mixed oxide coatings

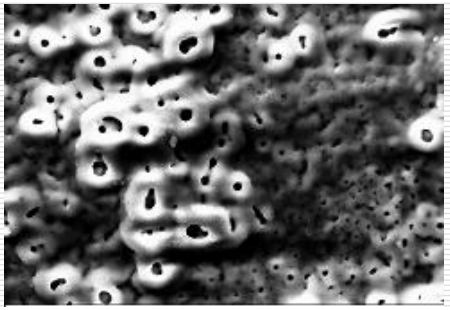
- Coatings formed in the PEO mode have an increased corrosion resistance and an intense catalytic activity in carbon (II) oxide oxidation reaction. Thus, there is a prospect of using such coatings in the industrial systems of catalytic purification of exhaust gases
- Refractory and rare metals (W, Mo, V, Zr) are incorporated into the growing oxide phase by subsequent chemical and thermal reactions, which allows forming mixed conversion materials of various composition and surface morphology in one stage.



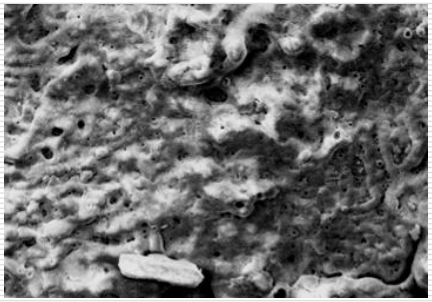
$TiOx{\cdot}MnO_y$



$TiO_x{\cdot}CoO_y$

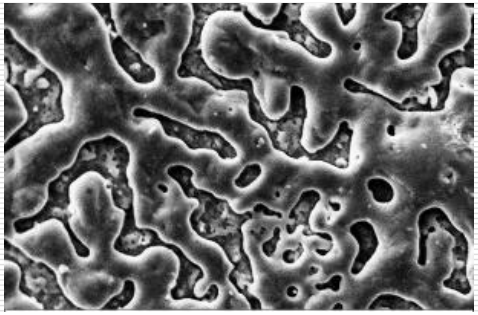


$TiO_x{\cdot}WO_y$

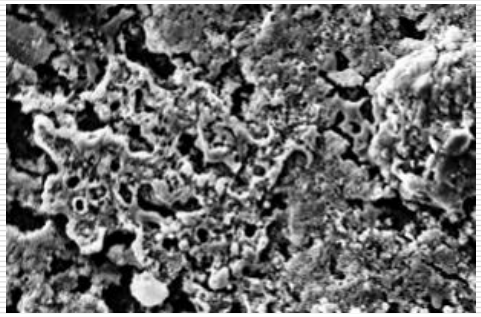


$TiO_x{\cdot}ZrO_2$

Mixed oxides on Aluminum alloys



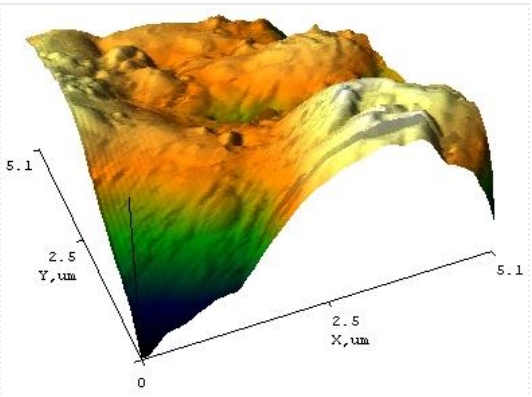
$Al/Al_2O_3 \cdot CoO_x$

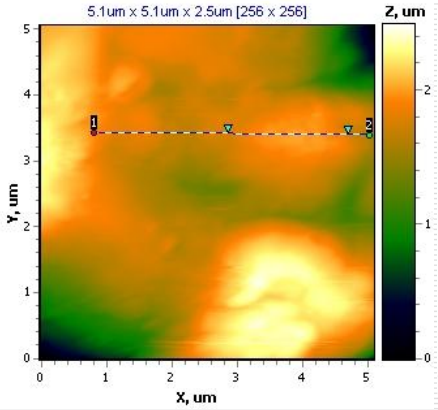


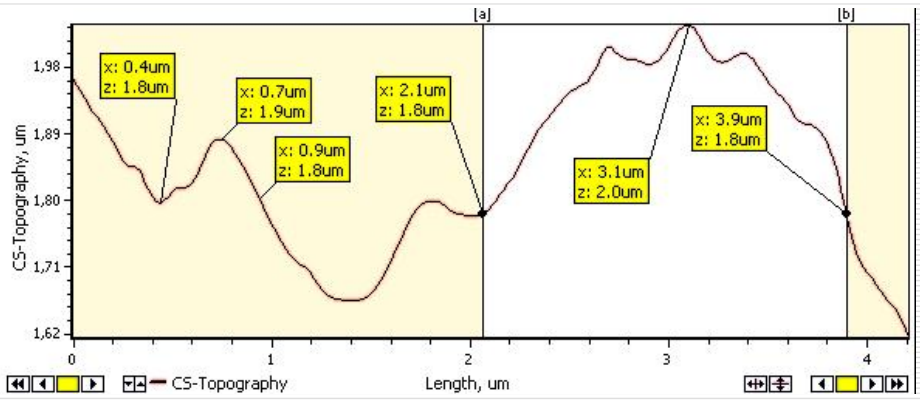
$Al/Al_2O_3 \cdot CoO_x$, MnO_y

- Mixed Aluminum and d-metals oxides on on the surface of the piston combustion chamber of single-cylinder diesel engine influences the features of the burnt areas at the wall surface, which in turn reduces an hour expense of fuel on 1–3% and positive effects on its environmental performance.
- Cobalt oxide coating on piston provides reduce NO_x emissions by 4–5% in the load range from 50 to 100%, where NO_x concentration is the most significant.

Topography for $Al_2O_3 \cdot CoO_x$ oxide coatings





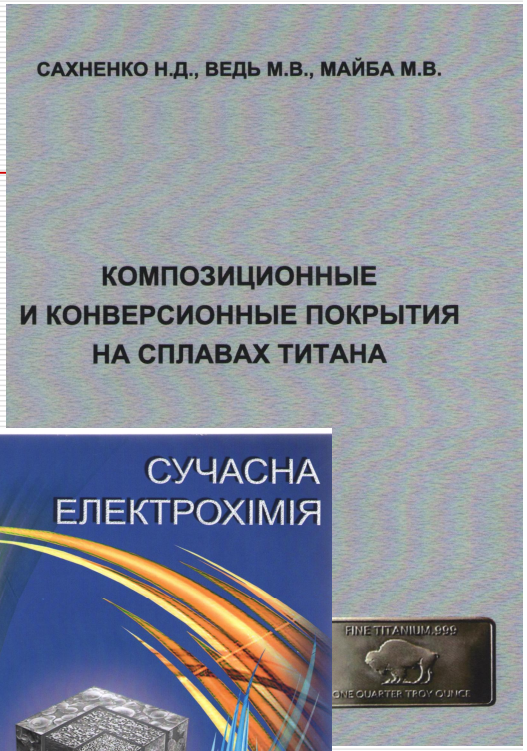


Microglobular surface pattern of oxide coatings is a prerequisite for a high catalytic activity in heterogeneous red-ox reactions

Catalytic systems **AL25|$Al_2O_3 \cdot CoO_X$** → directly on the parts of cylinder piston ICE

Books & papers

- **N. Sakhnenko, M. Ved, G. Karakurkchi et al. A study of synthesis and properties of manganese-containing oxide coatings on alloy VT1-0, *Eastern-Europian Journal of Interprise Technologies*. – 2016. – Vol.3. – 5(81). – 37–43. DOI: 10.15587/1729-4061.2016.69390**
- **N. Sakhnenko, M. Ved', D. Androshchuk et al. Formation of Coatings of Mixed Aluminum and Manganese Oxides on the AL25 Alloy, *Surface Engineering and Applied Electrochemistry*, 2016, Vol. 52, No. 2, pp. 145–15. DOI : 10.3103/S1068375516020113**
- **N. Sakhnenko, M. Ved, V. Bykanova. Characterization and photocatalytic activity of Ti/TinOm·ZrxOy coatings for azo-dye degradation, *Functional materials*. – 2014. Vol. 21. – no. 4. – pp. 492-497. http://dx.doi.org/10.15407/fm21.04.492**
- **V. Bykanova, N. Sakhnenko D., M. Ved' Synthesis and Photocatalytic Activity of Coatings Based on the TixZnyOz System, *Surface Engineering and Applied Electrochemistry*, 2015, Vol. 51, No. 3, pp. 276-282. DOI: 10.3103/S1068375515030047**



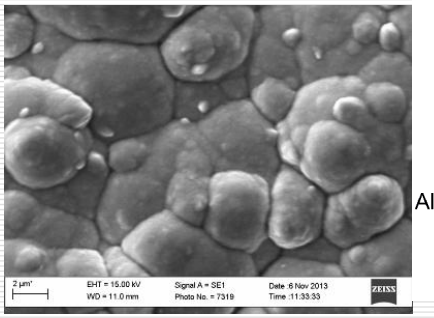
Electrochemical synthesis of composite coatings based on metallic matrix reinforced by nanoscale oxides

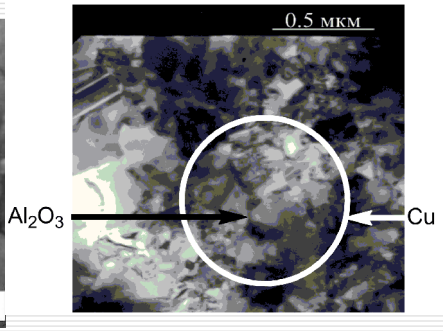
- Electro-synthesis of composite coatings based on metallic matrix (Nickel, Copper, Iron, Cobalt) reinforced by nanoscale Aluminum, Titanium and Zirconium oxides to enhance the microhardness, yield strength, tensile strength without reducing ductility of monometallic covers.

Composite coatings reinforced by nanoscale Al_2O_3 oxides

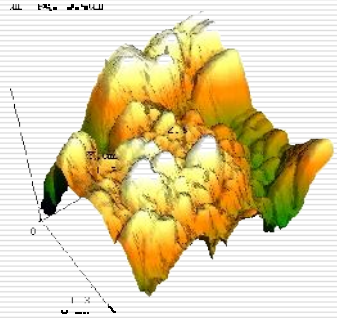
- Results of mechanical tests indicate increased ductility, strength and other physical-mechanical properties of the synthesized composite materials.
- Inclusion in the basic matrix of Cu and Ni nanosized particles of aluminum oxide leads to a decrease in the size of grains.

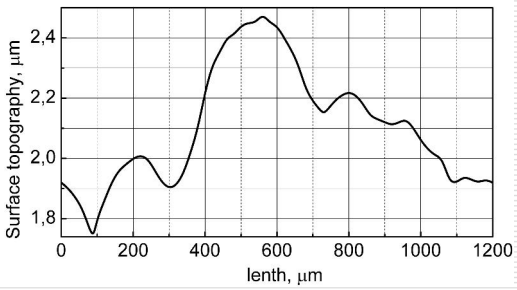
Coatings and foil Cu–Al_2O_3



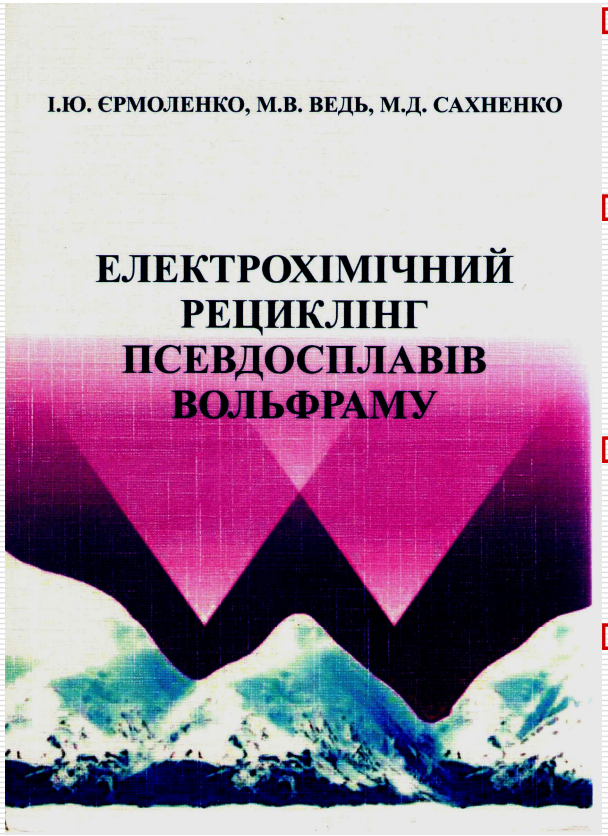


Coatings and foil Ni–Al_2O_3





Books & papers



- N. Sakhnenko, O. Ovcharenko, M. Ved. Copper (nickel) based composite coatings reinforced with nanosized oxides, *Functional Materials*, 2015, Vol.22, no 1. – P.105 – 109. http://dx.doi.org/10.15407/fm22.01.105
- N. Sakhnenko, O. Ovcharenko, M. Ved' Electrochemical Synthesis of Nickel-Based Composite Materials Modified with Nanosized Aluminum Oxide, *Russian Journal of Applied Chemistry*, 2015, Vol. 88, No. 2, pp. 267−271. DOI: 10.1134/S1070427215020123
- M. Sakhnenko, O. Ovcharenko, M. Ved' et al. Physicomechanical Properties of Cu −Al2O3 Electroplating Compositions, *Materials science*, 2015, Vol. 50, No. 5, pp. 646-652. DOI 10.1007/s11003-015-9766-3
- N. Sakhnenko, O. Ovcharenko, M. Ved' Electrodeposition and Physicomechanical Properties of Coatings and Foil of Copper Reinforced with Nanosize Aluminum Oxide, *Russian Journal of Applied Chemistry*, 2014, Vol. 87, No. 5, pp. 596−600. DOI: 10.1134/S1070427214050103

Electrodeposition of multicomponent alloy coatings

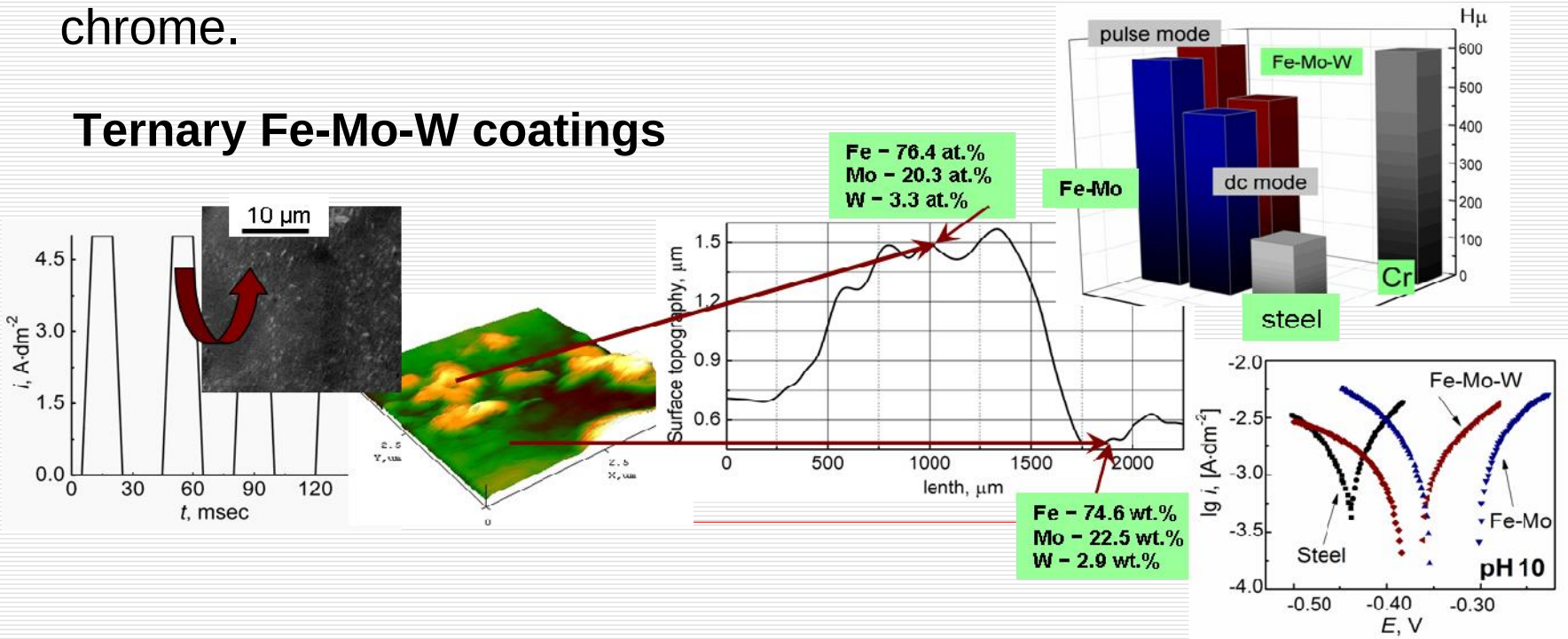
Electrodeposition (pulse and stationary) of binary and multicomponent coatings based on iron family metals (Fe, Co, Ni) alloying by refractory (Mo, W, V) and rare (Ti, Zr) with wide range functional properties:

- high corrosion resistance and chemical stability,
- microhardness, low coefficient of friction,
- catalytic activity in electrochemical hydrogen evolution process, organic substances oxidation, wastes purification.

Electrodeposition of Fe-Mo-W alloys

The amorphous structure of alloys and significant content of alloying elements (Mo and W) predetermine improved physical and mechanical properties of deposits as well as high corrosion resistance. Ternary alloys can be recommended to replace chromium deposits due to their microhardness being close to electrolytic chrome.

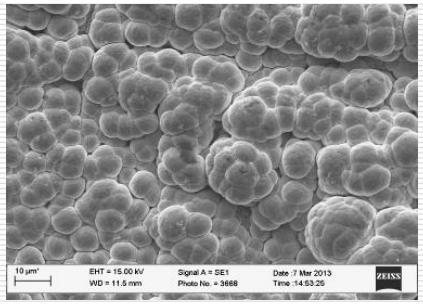
Ternary Fe-Mo-W coatings

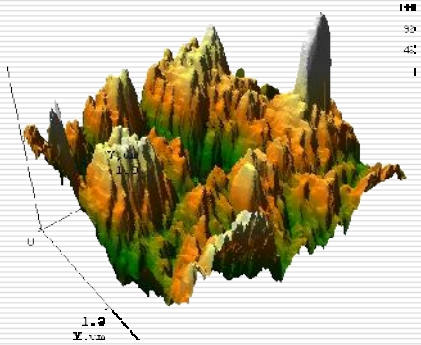


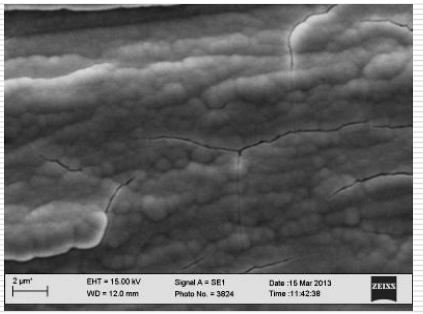
Electrodeposition of multicomponent alloys coatings

- Physico-mechanical properties and corrosion-resistance, combined with the high deposition rate and the stability of the electrolyte, make it possible to recommend Fe-Mo and Fe-Mo-W coatings for use not only as means of protection, but also in techniques for restoration of worn articles.

Ternary Co(65)-Mo(15)-W(20) and Co(75)-Mo(21)-Zr(4) coatings



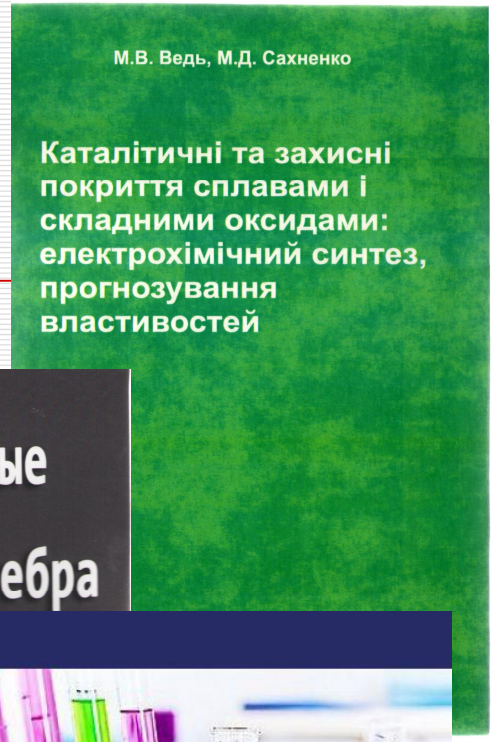


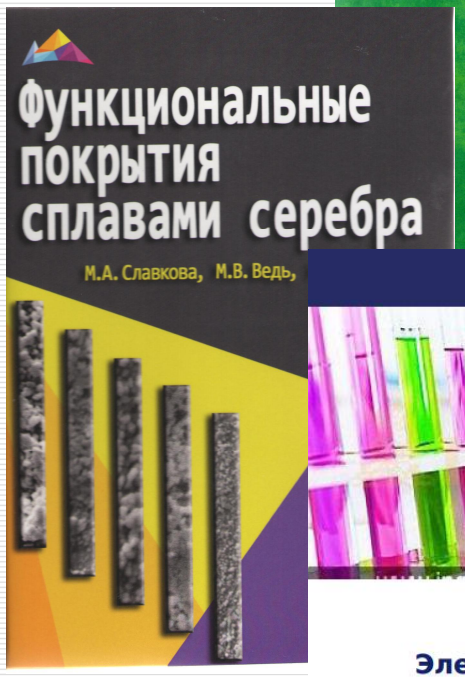


Microhardness *HV* – 850…1100.

Books & papers

- G. Yar-Mukhamedova, M. Ved', N. Sakhnenko et al. Iron binary and ternary coatings with molybdenum and tungsten, *Applied Surface Science*, 2016, V. 383, pp. 346–352. DOI 10.1016/j.apsusc.2016.04.046
- A. Karakurkchi, M. V. Ved', N. D. Sakhnenko et al. Electrochemical Deposition of Fe–Mo–W Alloy Coatings from Citrate Electrolyte, *Surface Engineering and Applied Electrochemistry*, 2016, Vol. 52, No. 1, pp. 43–49. DOI: 10.3103/S1068375516010087
- N. D. Sakhnenko, M. V. Ved, Yu. K. Hapon et al. Functional Coatings of Ternary Alloys of Cobalt with Refractory Metals, *Russian Journal of Applied Chemistry*, 2015, Vol. 88, No. 12, pp. 1941−1945. DOI: 10.1134/S1070427215012006X
- A. Karakurkchi, M. Ved', N. Sakhnenko et al. Functional properties of multicomponent galvanic alloys of iron with molybdenum and tungsten, *Functional Materials*, 2015, Vol.22, № 2.–P.181-187. doi:http://dx.doi.org/10.15407/fm22.02.181
- M. Ved', N. Sakhnenko, A. Karakurchi et al. Electrodeposition of Iron–Molybdenum Coatings from Citrate Electrolyte, *Russian Journal of Applied Chemistry*, 2014, Vol. 87, No. 3, pp. 276−282 DOI: 10.1134/S1070427214030057

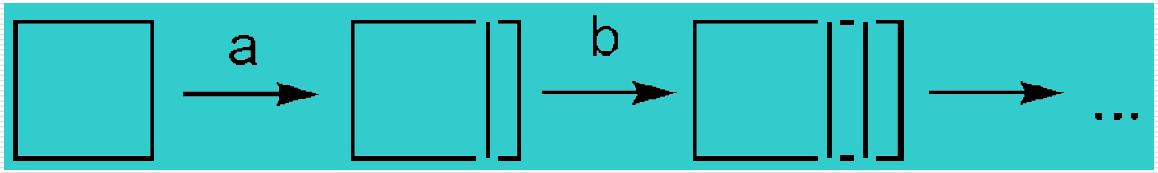




Smart materials – Synthesis and Applications

- Sakhnenko N.D., Proskurin N.N., Ved M.V. et al. Energysaving technology synthesis of active dielectrics multilayer coatings // Integrated technologies and energy saving, 2012. – №. 3 – P.8–10
- Sakhnenko N.D., Ved M.V., Proskurin N.N. et al. Electrophoretic deposition of ferroelectric on the metal substrate with ferrite coating // Issues of Chemistry and Chemical Technology – 2012.–№3.–C.163–166.
- Электрохимический синтез слоистых структур из активных диэлектриков / Н.Н. Проскурин, Н.Д. Сахненко, М.В. Ведь, и др. // Свиридовские чтения. – Минск : БГУ, 2013. – № 9 – С. 145 – 151.
- Modification of electrode materials by alloys and oxide systems / M.Sakhnenko, M. Ved, O.Bogoyavlenska et al / International conference "Ion transport in organic and inorganic membranes" / Conference Proceedings. Krasnodar, 6 – 11 June 2011. – Krasnodar, 2011. – P. 177.

Smart Material Nanolaminate : Sintesys Strategy by Plasma electrolytic oxidation (PEO) and Electrophoretic Deposition (EPD) Integration



Al → Al + Film(I) → Al + Film(I) + Film(II)

Film (I) – [Al_2O_3 +$ZnFe_2O_4$]

Film (II) – [$Ba_xSr_{(1-x)}Ti_yZr_{(1-y)}O_3$]

a = f (U, j, μ_e, ρ, μ_f, R_a, …) **by PEO**

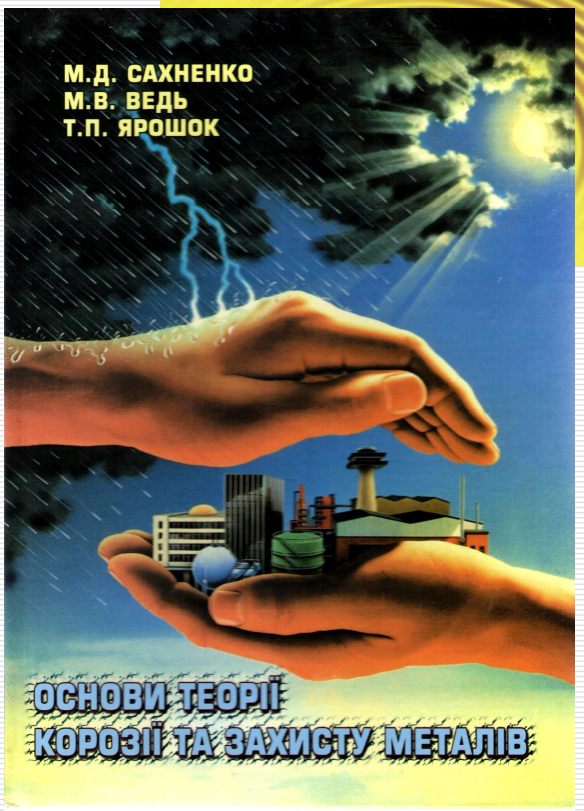
b = f [U, j, μ_e, μ_2, q (abs, sign), …] **by EPD**

Corrosion & Ecology monitoring : top problems of our investigation

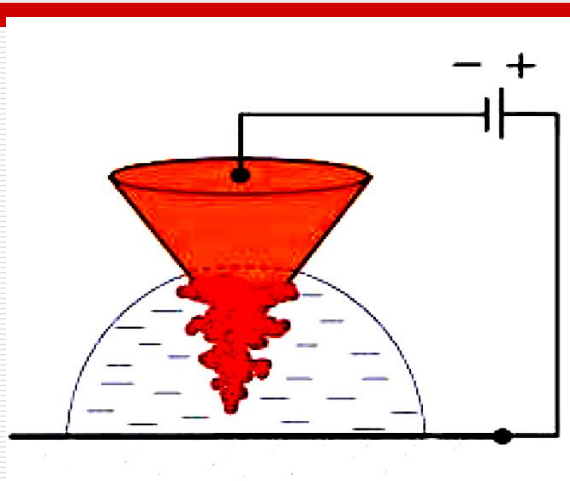
- Organic protective coatings service life prediction under operating conditions
- Pitting resistance of stainless steels in hot-water supply systems
- Analysis of local electrochemical processes during material degradation under environmental and operating conditions
- Corrosion inhibitors and nanoscale protective coatings from podand-containing solutions
- Chromate free treatment of aluminum alloys

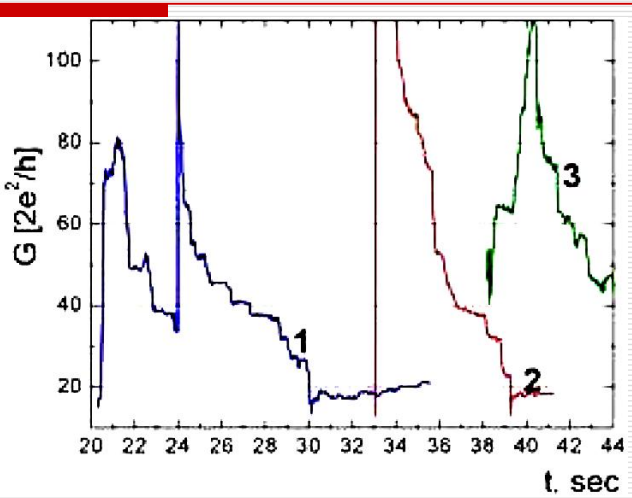
Books & papers

- Koziar M.A., Slavkova M.A., Sakhnenko N.D., Ved' M.V. Corrosion – electrochemical properties of Cobalt – Molybdenun – Zirconium deposits / Promising materials and processes in technical electrochemistry : Monograph. – Kyiv, 2016. – P. 127-131
- M. Glushkova, M. Ved, M. Sakhnenko, Corrosion properties of cobalt-silver alloy electroplates, *Materials science*, 2013, Vol. 49, No. 3, pp. 292-297.
- M. Ved, M. Sakhnenko, V. Shtefan et al. Computer modeling of the nonchromate treatment of aluminum alloys by neural networks, *Materials science*, 2008, Vol. 44, No. 2, pp. 216-221
- M. Ved, M. Sakhnenko, O. Bohoyavlens'ka et al. Modeling of the surface treatment of passive metals, *Materials science*, 2008, Vol. 44, No. 1, pp. 79-86.
- O.S.Shepelenko, M.D.Sakhnenko, V.H. Shtamburh, Formation of nanoscale protecticve coatings on iron alloys from podand-containing solutions // Materials Science, 2012.- vol.48, No 2.- P.203-207.



New generation of quantum sensors

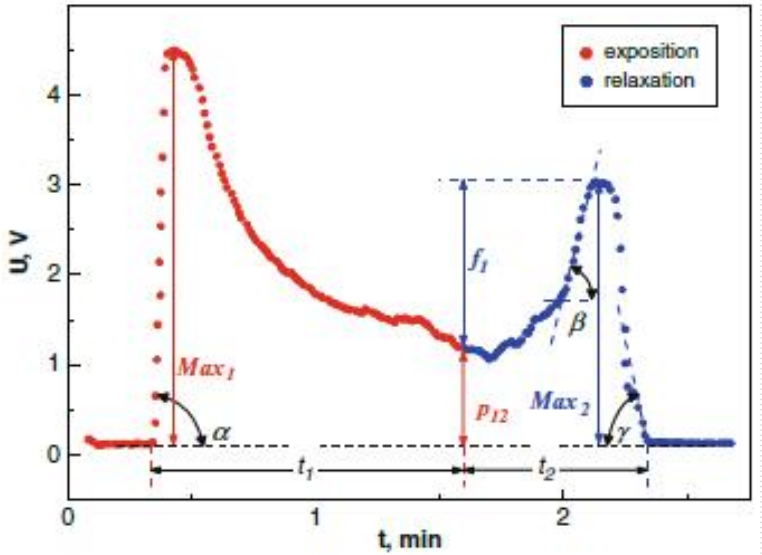




- Quantum electrical characteristics of dendritic copper point contacts (PCs) formed through an electrochemical process via a new cyclic switchover effect demonstrated the occurrence of steps in the time dependence of the dendritic-PCs conductance. We show that this quantization of the electrical conductance is due to an electronic shell effect governing the dendrite growth. The cyclic variations of conductance during dendritic PCs electrosynthesis offer the possibility for forming nanostructures of preassigned sizes controlled through their electrical resistance. Such effects open wide perspectives for design new sensors for lquid and gaseous media differential analysis.
- Investigations are performed in cooperation with B. Verkin Institute for Low Temperature Physics and Engineering.

Pospelov, A.P., Pilipenko, A. I., Kamarchuk, G. V., Fisun, V. V., Yanson, I. K., and Faulques, E., A New Method for Controlling the Quantized Growth of Dendritic Nanoscale Point Contacts via Switchover and Shell Effects. J. Phys. Chem. C, 2015. 119(1): p. 632-639.

New generation of breath tests for *Helicobacter pylori* detection



The problem of detection and eradication of *Helicobacter pylori* (*H. pylori*) infection is of great importance all over the world because of its role in development of different severe gastric and duodenal diseases. The study of exhaled gas in adolescents patients was conducted using the point-contact gas-sensitive nanosensors based on derivatives of salts of TCNQ in accordance with the method developed by our group. Response curves of the point-contact sensors to breath gas action were registered after an overnight fast of the subjects. Point-contact sensors are a principally new type of nanosensors operating on the fundamentals of Yanson point-contact spectroscopy and point-contact gas-sensitive effect. One of the original properties of point-contact sensors is complex response curves upon the action of complicated gas media which is similar to point-contact spectra. Investigations are performed in cooperation with B. Verkin Institute for Low Temperature Physics and Engineering of NASU and Department of Pediatrics, SI "Institute for Children and Adolescents Health Care" of NAMS of Ukraine,

A.Pospelov, M.Ved, N.Sakhnenko, Yu. Alexandrov, V. Shtefan, A.Kravchenko, G. Kamarchuk High-conductivity organic metals as electrode materials. Materials Science, Vol. 20, No. 3, 2002.

IG. V. Kamarchuk, A. P. Pospelov, I. G. Kushch. Sensors for exhaled gas analysis: an analytical review, in Volatile biomarkers: non-invasive diagnosis in physiology and medicine, A. Amann and D. Smith, eds. Elsevier, Amsterdam, 265-300, 2013.

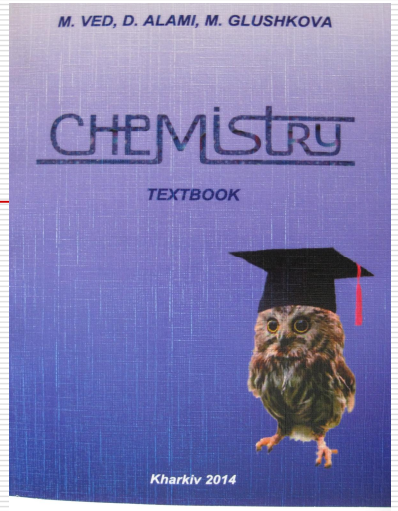
G. V. Kamarchuk, A. P. Pospelov, L. V. Kamarchuk, I. G. Kushch. Point-Contact Sensors and Their Medical Applications for Breath Analysis: A Review, in Nanobiophysics: Fundamentals and Applications, V.A. Karachevtsev, ed. Pan Stanford Publishing Pte. Ltd., Singapore, 327-379, 2015.

EDUCATION


ПРАКТИЧНИЙ КУРС
ОСНОВИ ХІМІЇ БІОГЕННИХ ЕЛЕМЕНТІВ, БІОХІМІЇ І БІОФІЗИКИ
ВЕДЬ М.В.
ЯРОШОК Т.П.
САХНЕНКО М.Д.
ОРЕХОВА Т.Ю.
БУЛАВІН В.І.


САХНЕНКО М.Д., АРТЕМЕНКО В.М.
КІНЕТИКА ЕЛЕКТРОДНИХ РЕАКЦІЙ


МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ УКРАИНЫ
НАЦИОНАЛЬНЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ
«ХАРЬКОВСКИЙ ПОЛИТЕХНИЧЕСКИЙ ИНСТИТУТ»
А.В. ДЖЕНЮК, Ю.И. ДОЛЖЕНКО,
С.И. РУДНЕВА, Н.Д. САХНЕНКО, В.Л. ЧЕРГИНЕЦ
ТЕСТЫ ПО ФИЗИЧЕСКОЙ ХИМИИ
ДЛЯ ИНОСТРАННЫХ СТУДЕНТОВ НАПРАВЛЕНИЯ «ХИМИЧЕСКАЯ ТЕХНОЛОГИЯ»
УЧЕБНО-МЕТОДИЧЕСКОЕ ПОСОБИЕ
Под общей редакцией Ю.И. Долженко
Харьков 2015
НТУ «ХПИ»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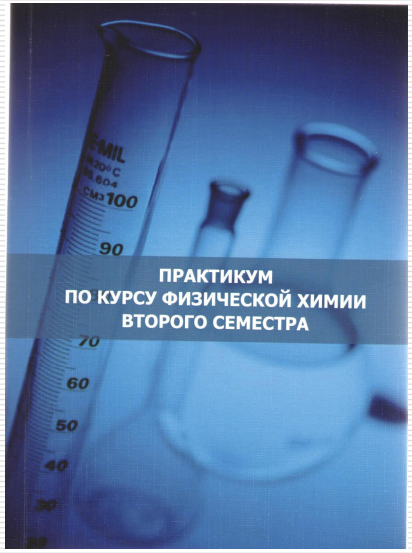
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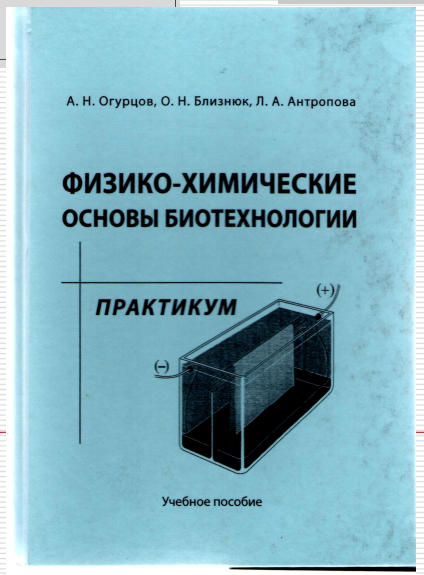
А. Н. Огурцов, О. Н. Близнюк, Л. А. Антропова
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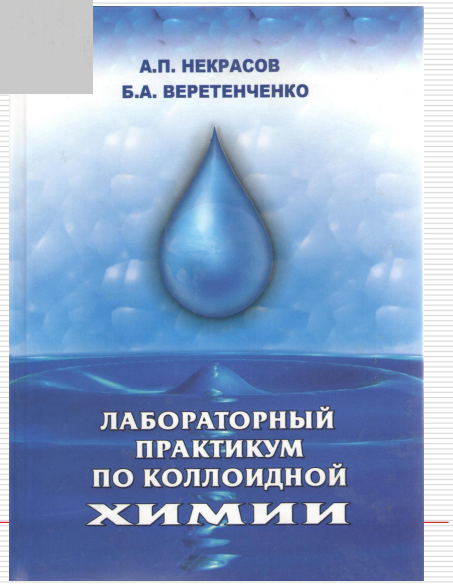
Учебное пособие


А.П. НЕКРАСОВ
Б.А. ВЕРЕТЕНЧЕНКО
ЛАБОРАТОРНЫЙ ПРАКТИКУМ ПО КОЛЛОИДНОЙ ХИМИИ