National Technical University
"Kharkov Polytechnic Institute"
The General and Inorganic Chemistry Department

Proposal

for cooperation

of General and Inorganic Chemistry Department

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Our Fields of Research

We are interested in cooperation in the fields of:

- **Physical Chemistry;**

Structure and Dynamics of Electrolytes in Nonaqueous solutions; Transport and equilibrium properties of proton in nonaqueous solvents (we would like to start cooperation with Institute of Chemistry (ICH));

- **Waste Treatment;**

Thermal regeneration of sulfuric acid from spent etching solutions containing sodium sulfate; Purifying of waste water containing formaldehyde (we would like to start cooperation with Institute of Fluid Dynamics and Thermodynamics (ISUT), Institute of Process Engineering (IVT));

- **Metal Coatings.**

Plasma electrolytic oxidation (PEO) of aluminum and titanium alloys; Electro-deposition of binary and multicomponent coatings; Corrosion monitoring and corrosion protection(we would like to start cooperation with Institute of Process Engineering (IVT));

Our Developments

- Sulfuric acid thermal regeneration from spent solutions after the glass fiber etching.

Sulfuric acid can be returned in the production cycle and sodium sulfate can be utilized as addition to the charge for glass melting. Processing begins with a clarification of spent solution by coagulation of organic impurities with montmorillonite clay. After that clarified solution partially evaporates in a special acid-resistant boiler heated by flue gases from the glass-furnace. The hot concentrated solution then sprays via nozzles to the "fluidized" bed reactor blown with hot (approx. 850ºC) products of combustion. The solution decomposes here to sulfuric acid vapor and a granular sodium sulfate. The vapor condenses, giving a concentrated sulfuric acid, which suitable for preparation of etching solution.

- Catalytic neutralization of formaldehyde-containing wastewater.

Formaldehyde-containing wastewater (FCW) is mainly produced in the synthesis of methanol, formaldehyde (FA) and formaldehyde resins. The content of FA in FCW is thousands of times higher than the maximum permissible concentration (0.05 mg/dm^3). This technology is based on liquid-phase catalytic oxidation of FSV ($Ce_{0,23}Mn_{0,77}O_2$ catalyst). It is more efficient and less energy-intensive than the aldolisation method: process temperature decreases from 96°C to 65°C; increases the degree of purification from 80% to 99%, i.e. almost to the maximum permissible concentration; provided the pH at 6.5÷7.5; chemical oxygen demand reduces 10÷15 times; no need to dilute the waste water after cleaning to ensure the compliance of maximum permissible concentration of FA.

Our Developments

- Plasma electrolytic oxidation (PEO) of aluminum and titanium alloys.

The plasma electrolytic oxidation of the VT1-0 alloy in pyrophosphate solutions facilitates the formation of enamel-like oxide coatings of a microglobular morphology including a mixture of the titanium oxides. By varying the concentration of the electrolyte and the current density for forming, it is possible to control the chemical and phase compositions of coatings as well as the topography of the surface and the grain size. TiOx coatings formed in the PEO mode with reduction of the grain size and formation of a microglobular structure have an increased high corrosion resistance and chemical stability, high wear resistance, low coefficient of friction.

- Electro-deposition of binary and multicomponent coatings based on iron family metals (Fe, Co, Ni) alloying by refractory (Mo, W, V) and rare (Ti, Zr) metals.

Application of unipolar pulsed current allows receiving relatively high current efficiency and uniform deposit with less nonmetallic impurities and increased content of molybdenum and tungsten in a deposit. Irrespective of the deposition mode alloys have amorphous structure and the grains of deposits obtained in the pulsed mode consist of agglomerates with a diameter of 0.2–0.4 microns. 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. The corrosion rate of such deposits in all corrosive media is lower and microhardness is 2–4 times higher than that of the substrate. Due to their microhardness being close to electrolytic chrome deposits, ternary alloys can be recommended to replace chromium deposits.

Our Publications

1. Alami, D., Bulavin, V. (2013). Synthesis and Characterization of $Ag/Ce_{1-x}Mn_xO_{2-\delta}$ Oxidation Catalysts. Bulletin of Chemical Reaction Engineering & Catalysis, 8 (1): 83-88. (doi:10.9767/bcrec.8.1.4718.83-88)
2. V.P. Ulyanov, V.I. Bulavin, A.V. Kramarenko, I.V. Ulyanova, Yu.V. Permyakov Reducing treatment of iron-containing dusts and slams from basic metallurgical conversion with obtaining of metallized pellets // Integrated Technologies and Energy Conservation. – 2015. – № 1 – c. 110-118
3. V.P. Ulyanov, V.I. Bulavin, A.V. Kramarenko, I.V. Ulyanova, Yu.V. Permyakov. An automated control of technology of reducing treatment of iron-containing dusts and slams from basic metallurgical conversion with obtaining of metallized pellets// Integrated Technologies and Energy Conservation. – 2015. – № 1 – c. 27-31
4. Alami, D., Bulavin, V., Gurina G.I. The technology of formaldehyde-containing wastewater treatment from production of paints // Integrated Technologies and Energy Conservation . — №3, 2013. p.33-43.
5. Ryshenko I, Bulavin V., Yurchenko A. Blinkov N. Influence of solubility in the water on their tendency to crystal hydrates// EUREKA: Physical Sciences and Engineering, 2016. – № 1. – P. 82-86.
6. 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
7. 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
8. 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/S107042721501200 6X
9. 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