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LETTERS TO THE EDITOR

Surface Properties of Langmuir–Blodgett Films and Nanodispersed Oxides Containing Nickel and Copper

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The structures exhibiting specific sorption properties have recently attracted considerable attention [1]. Sorbents containing a metal ion strongly bound at the substrate are of special interest for metal-affine chromatography [2–4]. Earlier we have shown that such structures containing Fe^{III} ions can be used as metal-affine sorbents [5, 6]. Therefore we assumed that Langmuir–Blodgett films based on metal stearates and nanodispersed metal oxides with a developed surface can exhibit such specific sorption properties [7, 8]. To verify this assumption, we prepared collapsed films of copper and nickel stearates and nanosized oxides of the same metals.

The films of copper and nickel stearates with average mass of 0.002 g per 100 cm^2 were prepared via the Langmuir–Blodgett method. Chemical analysis of the metals contents showed that the fraction of copper (nickel) at the surface of stearic acid monolayer was of 0.5, pointing at the complete conversion of stearic acid into distearate of the corresponding metal. Scanning electronic microscopy (SEM) examination of the collapsed monolayers of copper and nickel stearates revealed the layered structures that were further used in the study of the electrokinetic potential as a function of the solution pH. The isoelectric points were found at 3.9 and 3.5 pH units for the films based on nickel and copper stearates, respectively.

Nickel and copper oxides were synthesized via microwave treatment of aqueous solutions containing carbamide and the corresponding metal nitrate. The X-ray analysis revealed that the single-phase oxides without any admixtures of the starting compounds were formed; the recorded reflexes were well resolved, and no splitting was observed. Nickel and copper oxides had the bunsenite and the tenorite structures, respectively. In the both cases, the peaks were somewhat broadened, possibly pointing at sufficiently high dispersity and small particle size of the resulting oxides. The SEM method showed that the formed oxides contained spherical aggregates of about 500 nm.

The synthesized oxides were studied with nitrogen low-temperature sorption (BET). The hysteresis loop and characteristic inflection at low relative pressure allowed assignment of the sorption isotherm to the type IV according to the IUPAC nomenclature, evidencing about the mesoporous structure of the oxides. The specific surface area of copper and nickel oxides was of 2 and 90 m^2/g, respectively.

It was found that both the films of copper and nickel stearates and the oxides of those metals exhibited the metal-affine activity towards *N*-(phosphonomethyl)glycine and aminomethylphosphonic acid, i.e. they could be used as sorbents. After extraction from an aqueous medium via metal-affine chromatography, those compounds were completely absent in the solution, whereas their extraction degree in eluate (0.4 mol/L NH_4OH) was at least 95% for each of the sorbents.

The films were synthesized via Langmuir–Blodgett device using an aqueous subphase containing 10^{-4} mol/L of copper or nickel nitrate. The surface of the aqueous subphase was coated with 100 μL of 5 mmol/L solution of stearic acid in hexane. After application of stearic acid solution onto the surface of the aqueous subphase, a monolayer of the corresponding stearate was formed; it was then collapsed with Teflon barriers. The resulting collapsed monolayer of nickel (copper) stearate was placed in a microtube and dried under air flow.

Nickel and copper oxides were synthesized from aqueous solutions containing the corresponding nitrates and carbamide under microwave irradiation (800 W).

X-ray analysis of the synthesized oxides was performed using a Bruker D2 Phaser powder diffractometer with copper and cobalt anodes at the scanning angles 2θ of 0–160°. The samples were identified using the Powder Diffraction File (PDF) diffraction data. Microscopic study of the obtained samples was carried out with a Hitachi S-3400N scanning electron microscope. Surface area and pore volume of the samples were measured by nitrogen low-temperature adsorption using an ASAP-2010N Micrometrics (USA) porometer.

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