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Ethanolamine Detection with Composite Films

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Abstract : The aim of the work was to get stable sensitive films with good sensitivity to ethanolamine (C2H7NO) in air. Ethanolamine is used as adsorbent in different processes of gas purification and separation. Besides it has wide industrial application. Chemical sensors of sorption type are widely used for gas analysis. Their behavior is determined by sensor characteristics of sensitive sorption layer. Forming conditions and characteristics of chemical gas sensors based on nanostructured modified silica films activated by different admixtures have been studied. As additives molybdenum containing polyoxometalates of the eighteen series were incorporated in silica films. The method of hydrolythic polycondensation from tetraethyl orthosilicate solutions was used for forming such films in this work. The method's advantage is a possibility to introduce active additives directly into an initial solution. This method enables to obtain sensitive thin films with high specific surface at room temperature. Particular properties make polyoxometalates attractive as active additives for forming of gas-sensitive films. As catalyst of different redox processes, they can either accelerate the reaction of the matrix with analyzed gas or interact with it, and it results in changes of matrix's electrical properties Polyoxometalates based films were deposited on the test structures manufactured by microelectronic planar technology with interdigitated electrodes. Modified silica films were deposited by a casting method from solutions based on tetraethyl orthosilicate and polyoxometalates. Polyoxometalates were directly incorporated into initial solutions. Composite nanostructured films were deposited by drop casting method on test structures with a pair of interdigital metal electrodes formed at their surface. The sensor's active area was 4.0 x 4.0 mm, and electrode gap was egual 0.08 mm. Morphology of the layers surface were studied with Solver-P47 scanning probe microscope (NT-MDT, Russia), the infrared spectra were investigated by a Bruker EQUINOX 55 (Germany). The conditions of film formation varied during the tests. Electrical parameters of the sensors were measured electronically in real-time mode. Films had highly developed surface with value of 450 m2/g and nanoscale pores. Thickness of them was 0,2-0,3 μm. The study shows that the conditions of the environment affect markedly the sensors characteristics, which can be improved by choosing of the right procedure of forming and processing. Addition of polyoxometalate into silica film resulted in stabilization of film mass and changed markedly of electrophysical characteristics. Availability of Mn3P2Mo18O62 into silica film resulted in good sensitivity and selectivity to ethanolamine. Sensitivity maximum was observed at weight content of doping additive in range of 30–50% in matrix. With ethanolamine concentration changing from 0 to 100 ppm films' conductivity increased by 10-12 times. The increase of sensor's sensitivity was received owing to complexing reaction of tested substance with cationic part of polyoxometalate. This fact results in intramolecular redox reaction which sharply change electrophysical properties of polyoxometalate. This process is reversible and takes place at room temperature.

Keywords : ethanolamine, gas analysis, polyoxometalate, silica film
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