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Nanowire Sensor Based on Novel Impedance Spectroscopy Approach

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Abstract : Modern sensorics imposes strict requirements on the biosensors characteristics, especially technological feasibility, and selectivity. There is a growing interest in the analysis of human health biological markers, which indirectly testifying the pathological processes in the body. Such markers are acids and alkalis produced by the human, in particular - ammonia and hydrochloric acid, which are found in human sweat, blood, and urine, as well as in gastric juice. Biosensors based on modern nanomaterials, especially low dimensional, can be used for this markers detection. Most classical adsorption sensors based on metal and silicon oxides are considered non-selective, because they identically change their electrical resistance (or impedance) under the action of adsorption of different target analytes. This work demonstrates a feasible frequency-resistive method of electrical impedance spectroscopy data analysis. The approach allows to obtain of selectivity in adsorption sensors of a resistive type. The method potential is demonstrated with analyzis of impedance spectra of silicon nanowires in the presence of NH3 and HCl vapors with concentrations of about 125 mmol/L (2 ppm) and water vapor. We demonstrate the possibility of unambiguous distinction of the sensory signal from NH3 and HCl adsorption. Moreover, the method is found applicable for analysis of the composition of ammonia and hydrochloric acid vapors mixture without water cross-sensitivity. Presented silicon sensor can be used to find diseases of the gastrointestinal tract by the qualitative and quantitative detection of ammonia and hydrochloric acid content in biological samples. The method of data analysis can be directly translated to other nanomaterials to analyze their applicability in the field of biosensory.

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