【Grant-in-Aid for Scientific Research (S)】

Broad Section C

Title of Project : Fundamental Study of Robust Molecule Recognition Electronics

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Keyword : Nanomaterials, Molecule Recognition, Electronics

【Purpose and Background of the Research】

Sensor electronics that measures our personal information in "long term" and accumulate in cyberspace opens up new academies and industries. Currently, a robust physical sensor is the mainstream of its research, but molecular sensor electronics that distinguishes "chemical" molecular information (biological gas etc.) in the long term "electric" is still limited. In this research, we develop "robust molecular sensor electronics" as a bridge of chemical information between real world and cyber space around us by metal oxide nanowire interface with molecular identification function and integrated hybrid molecular sensor.

【Research Methods】

Using a group of volatile molecules in exhaled breath as a target, we investigate the molecule's information on the surface of oxide nanowire surfaces including 1) functional groups (alcohols, aldehydes, ketones, carboxylic acids, amines), 2) molecular weight, 3) structural isomers, in order to verify the molecular recognition ability. As a verification method, the influence of these molecular skeleton parameters on molecular recognition ability (GC-MS desorption spectral analysis) is analyzed by the solid surface structure (TEM analysis, Raman spectroscopy) and molecular adsorption state (infrared spectroscopic pMAIRS method) In consideration of the information on the information. As a different approach, when a shell layer of core / shell nanowire structure is formed, a target molecule is interposed and a nanowire surface storing the molecular shape is formed. With this method, it becomes possible to conduct experiments in a wider crystal growth atmosphere beyond the framework of anisotropic crystal growth, and it is expected that the range of applicable molecular species can be expanded.

By examining the temperature dependence, we verify the robustness of nanowire molecule identification function and its mechanism. Physical properties responsible for robustness are bond energies of metal ions and oxygen ions in oxides. An oxide nanowire having a molecular recognition function is formed as an integrated hybrid molecular sensor on a silicon substrate by utilizing a space selective crystal growth technique. I) an oxide nanowire structure as a molecular collector having a molecular recognition function and ii) a structure in which a current detection sensor part is hybrid arrayed on a micro / nanoscale. Regarding the molecular recognition ability, we will also consider improving the recognition ability by controlling the adsorption temperature in addition to the desorption temperature. Electrical molecular discrimination is carried out using various integrated hybrid molecular sensors fabricated for the aforementioned target molecule mixture. We demonstrate further improvement of molecular discrimination ability by multiplying the molecular discrimination ability on the oxide nanowire surface by the discrimination ability at the sensor part.

【Expected Research Achievements and Scientific Significance】

"Rigid" oxide nano surface spreads to research fields that distinguish "soft" molecular shape, and not only sensor research but also a wide spread effect on molecular selective catalyst research field is expected. By utilizing its robustness, deployment to an IoT molecular sensor that enables constant breath diagnosis by smartphones and the like is a major industrial development.

【Publications Relevant to the Project】

・ Nanoscale Thermal Management of Single SnO_2 Nanowire: pico-Joule Energy Consumed Molecule Sensor, G.Meng, F.Zhuge, K.Nagashima, A.Nakao, M.Kanai, Y.He, M.Boudot, T.Takahashi, K.Uchida and T.Yanagida, ***ACS Sensors***, 1, 997 (2016).

・ Long-Term Stability of Oxide Nanowire Sensors via Heavily-Doped Oxide Contact, H.Zeng, T.Takahashi, M. Kanai, G.Zhang, Y.He, K.Nagashima and T.Yanagida
ACS Sensors, 2, 1854 (2017). *Cover of ACS Sensors*

【Term of Project】 FY2018-2022

【Budget Allocation】 150,200 Thousand Yen

【Homepage Address and Other Contact Information】

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