Transport properties of the Bi_2S_3 nanowires for realisation in humidity sensors

Ivita Bite[1], Gunta Kunakova[1], Raimonds Meija[1], Juris Prikulis[1], Justin D. Holmes[2], Donats Erts[1]
[1]Institute of Chemical Physics, University of Latvia, Latvia
[2]Centre of Research on Adaptive Nanostructures and Nanodevices (CRANN), Trinity College Dublin, Ireland
e-mail: Ivita.Bite@lu.lv

Semiconductor nanowires have been investigated for the application in chemical sensors. Because of the large surface to volume ratio and Debye length, nanowires exhibit excellent surface sensitivity and selectivity to different gaseous substances [1]. For fabrication of the nanowire senor devices, transport properties of the nanowires play a significant role in the sensing mechanism and sensitivity.

Bismuth sulphide (Bi_2S_3) is an n-type semiconductor with conduction provided by sulphur vacancies as an intrinsic property [2]. Modifying density of theses vacancies during the nanowire growth, one should obtain different properties of the Bi_2S_3 nanowire sensors. To our knowledge, Bi_2S_3 nanowires for sensing applications have not been studied comprehensively so far. Here we focus on characterisation of the nanowire transport properties under variable humidity levels for its possible application in sensor devices.

Bi_2S_3 nanowires were grown inside pores of anodized aluminium oxide membrane. Individual Bi_2S_3 nanowires were liberated from the template by dissolving it. After that the nanowires were drop-casted to a pre-patterned silicon substrate. Electron beam lithography was applied for electrodes patterning. RH sensitivity was measured in a temperature controllable gas chamber in inert atmosphere with different RH levels (5 – 80%).

Current – voltage measurements for individual Bi_2S_3 nanowires demonstrated nonlinear dependencies which can be attributed to the contacts with dominating Schottky barrier. It was found, that I-V characteristics have a hysteretic behavior with resistance switching effect. Switching occurs between characteristics resistances corresponding to values of the nanowire resistance after exposure with low and high RH levels.

References

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