

Silicon single-electron devices: Time-space control of transport and development of new functions

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【 Outline of survey 】

In most of electric products like PCs, mobile machines and other house-electric products, Si ICs are used and higher performance is required, leading to further shrinkage of transistors and higher integration. However, the theoretical and practical limit of shrinkage is approaching and in sight, and the thermal problem of ICs due to released heat becomes serious. In order to solve the problems, breakthrough is necessary both in devices and architectures.

The purpose of the present research project is to develop Si single-electron devices by controlling transport of individual electrons, which is completely different from the conventional transistors. In particular, we focus on Si multi-dot structures and fabricate the devices, in which a single-electron moves from one dot to another. It is expected that such precise time-and-space control of individual electrons can be made by photo-irradiation and/or AC gate voltages.

Thus, the target of this research is to achieve the paradigm shift from the use of the huge number of electrons as a signal messenger to the use of individual electrons. This may also leads to innovation of IC concept.

【 Expected results 】

By this research project, tunneling and transport of individual electrons can be controlled by photo-irradiation and AC-gate voltages in multi-dot Si single-electron devices, which are potentially suitable to a variety of applications. The expected results will enable us to achieve new signal processing similar to biological signal processing, which is the first application of electron-electron Coulomb interaction.

【 References by the principal researcher 】

Ratno Nuryadi, Hiroya Ikeda, Yasuhiko Ishikawa and Michiharu Tabe: “ Ambipolar Coulomb blockade characteristics in a two-dimensional Si multi-dot device ”, IEEE Trans. on Nanotechnology, vol. 2, No.4, pp. 231-235 (2003).

【 Term of project 】 FY 2004 - 2008

【 Budget allocation 】 78,100,000 yen

【 Homepage address 】

<http://nano.rie.shizuoka.ac.jp/laboratory/>