

Formation Scheme of Quantum Point Contacts Based on Nanogaps Using Field-Emission-Induced Electromigration

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➤ Introduction

● Quantum Point Contacts (QPCs)

- ➔ QPCs provide approaches to novel electronics ranging from spintronics to atomic switches.
- ➔ There are many experimental reports about QPCs using mechanically breaking junction method.
- ➔ However, experimental studies on QPCs fabricated on the insulating substrates are needed.

K. Terabe, T. Hasegawa, T. Nakamura, and M. Ando, Nature 433, 47(2005). K. I. Bolotin, F. Kuemmeth, and D. C. Ralph, Phys. Rev. Lett. 97, 127202 (2006).

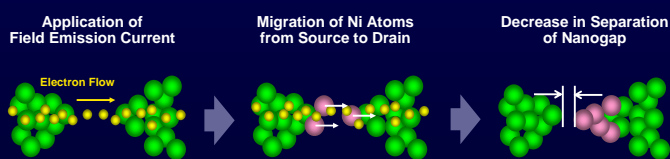
K. Sekiguchi, A. Yamaguchi, H. Miyajima, A. Hirohata, and S. Usui, Phys. Rev. B 78, 224418 (2008). T. Ono, Y. Ooka, and H. Miyajima, Appl. Phys. Lett. 75, 1622 (1999).

We propose a new approach for the fabrication of QPCs using field-emission-induced electromigration.

➤ Field-Emission-Induced Electromigration: "Activation"

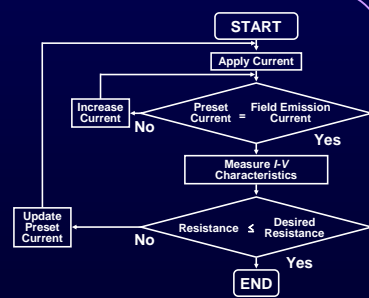
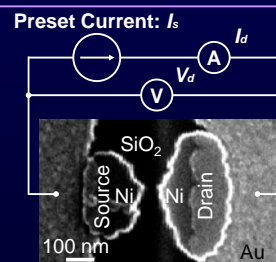
S. Kayashima, et al., Jpn. J. Appl. Phys. 46, L907 (2007).
T. Tomoda, et al., J. Vac. Sci. Technol. B 27, 813 (2009).

Schematic of Activation

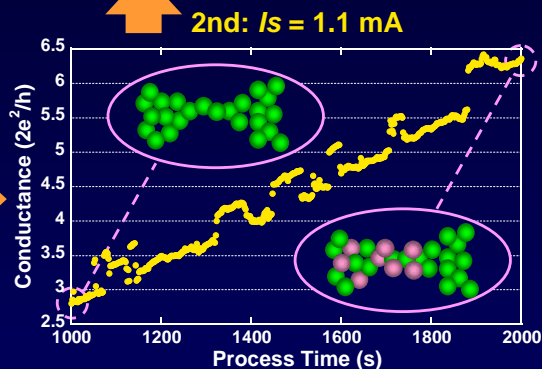
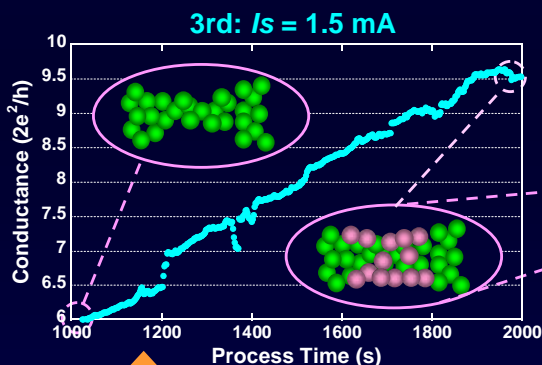
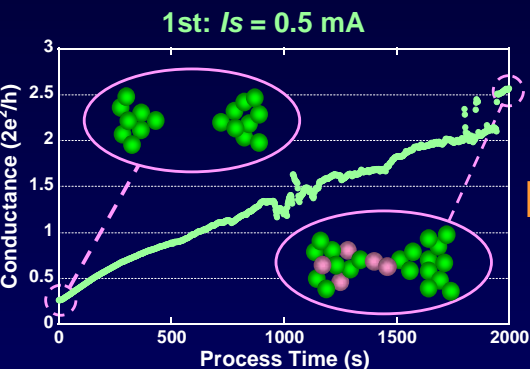
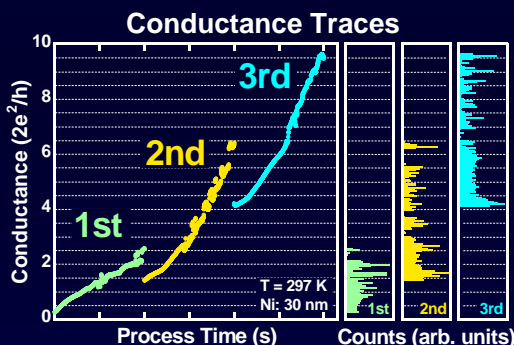


Simple Method for Controlling Tunnel Resistance

Activation Procedure

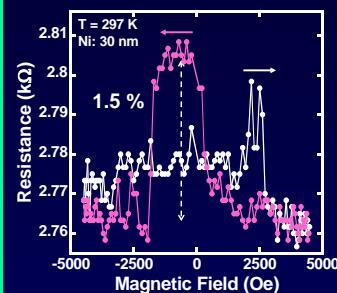
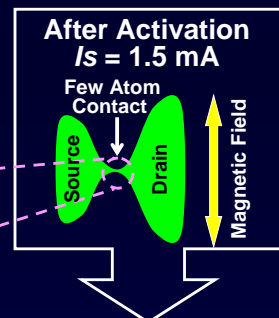


➤ Formation QPCs Using Activation Method



✓ Each conductance curve shows plateaus at integer multiples of $0.5 G_0 (= 2e^2/h)$.

➤ MR Property



Large MR Ratio

Enhanced AMR

K. I. Bolotin, et al., Phys. Rev. Lett. 97, 127202 (2006).

➤ Conclusions

● New Fabrication Scheme of QPCs Using Activation

- ➔ Conductance curves show the plateaus at integer multiples of $0.5 G_0 (= 2e^2/h)$ during the activation.
- ➔ It is suggests that QPCs is formed by only passing through nanogaps at room temperature.

This simple technique can be useful for the fabrication of QPC devices.