Single Electron Devices Using Silicon Nanocrystals

A. Souifi, S. Decossas, F. Mazen, G. Bremond, A. Poncet, and T. Baron
INSA–Lyon and CEA–LETI, France

These last years, silicon nanocrystals (nc-Si) have been extensively studied in order to develop silicon-based Single Electron Devices (SEDs). The use of a large number of silicon nanocrystals in non volatile memories has been demonstrated for many years.[1] Single electron transistors (SETs)[2] or single electron memories[3] operating at room temperature and using few (or single) nc-Si have been also demonstrated, respectively, in 1998 and 2000. Nevertheless, the control of the dot's number in the active device area and their position is still not achieved.

The studies of the nc-Si/SiO_2 system is however suitable for the development of future nanoelectronic devices for at least two reasons:

- It offers the possibility of device simulation and modeling including Coulomb Blocade, resonant tunneling, and 3D quantum confinement phenomena at room temperature. These models will be helpful in the case of deep sub-10 nm MOS devices that will show the quantum and Coulomb blocade effects at higher and higher temperatures as the size is reduced.[4]
- The nc-Si can really be used for the fabrication of highly integrated SEMs since the size and position of single dots can be achieved in a manufacturable manner.

In this work, we will first present an extensive study of the electronic properties and quality of LPCVD-deposited nc-Si. Then, we will show that it is possible to move the Si dots in order to make nanodevices with a reduced number of well-ordered nc-Si.[5] Current-voltage characteristics showing resonant tunneling effects at room temperature will be presented. The effects of offset charges will also be presented. Finally, we will show different ways for the fabrication of few and ordered quantum dot devices operating at room temperature.

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3 B. Hinds *et al.*, presented at *Quantum Dot Symp.*, Sapporo, Japan (2000).

4 F. Bœuf *et al.*, *Tech. Digest IEDM* (2001).

5 S. Decossas *et al.*, submitted to *Nanotechnology* (2003).