Dynamics of charges in a nanoscopic As-doped silicon barrier detected by SET electrometry

M. Hofheinz, X. Jehl, and M. Sanquer [1], G. Molas, M. Vinet, and S. Deleonibus [2]

[1] DSM-DRFMC-SPSMS-LaTEQS,
[2] DRT-LETI-D2NT-LNDE, CEA-Grenoble, 17 rue des Martyrs, F-38054 Grenoble cedex, France

We use silicon SET electrometers (1) to detect single Arsenic dopants in nanoscopic silicon tunnel barriers (2). This technique gives access to ionization state, spin and location of the dopants. On average 30 of them are implanted in the tunnel barrier and their ionization state is controlled by a gate. Dopants near the center of the tunnel barrier are fully characterized by real time measurements of the ionization state (2-3). The capacitive back action of the SET detector on the dopant is responsible for a periodic gate voltage modulation of the ionization state. Dopants located near the edges of the tunnel barrier are well connected to one electrode. Their dynamics is beyond the bandwidth of our SET detector but we follow such dynamics in the GHz range by analyzing the DC SET response under RF gate voltage modulation. The rates for trapping in the dopants is found to range from a few kHz up to a few GHz. Our Si :As nanoscopic tunnel barriers are model systems for a mesosocopic classical Coulomb glass and our experiments permit to investigate the frequency response of such a system as well as the charge rearrangements when the Fermi energy is varied (4-5).

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