Spin-dependent transport in ferromagnetic single-electron transistors with noncollinear magnetizations

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Theoretical analysis of spin-polarized transport through a ferromagnetic single-electron transistor (FM SET) has been carried out in the sequential tunneling regime [1]. Two external electrodes and the central part (island) of the device are assumed to be ferromagnetic, with the corresponding magnetizations being generally noncollinear. Apart from this, external gate voltage is applied to the island. Transport properties of FM SET are analyzed within the master equation approach, with the respective transition rates determined from the Fermi golden rule. It is assumed that spin relaxation processes on the island are sufficiently fast to neglect spin accumulation. It is shown that electric current and tunnel magentoresistance (TMR) strongly depend on the angle between magnetizations [2]. For an arbitrary magnetic configuration, TMR is modulated by the charging effects which lead to characteristic dips/cusps at the bias voltages corresponding to the Coulomb steps in the corresponding current-voltage characteristics. Transport characteristics of symmetrical and asymmetrical structures have been calculated for different values of the gate voltage. We have also calculated spin polarization of the electric current and its dependence on the gate voltage.

[1] Single Charge Tunneling Vol. **294** of NATO Advanced Study Institute, Series B, edited by H. Grabert and M.H. Devoret, Plenum Press, New York, 1992.
[2] J. Wiśniewska *et al*., Materials Science (Poland) **22** (2004) 461 and references therein.

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