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Increasing the capacitance beyond the classical limits in capacitors with free-electron like electrodes JAVIER JUNQUERA, PABLO GARCíA-FERNÁNDEZ, PABLO DE CASTRO-MANZANO, CITIMAC, Universidad de Cantabria, Avda. de los Castros s/n, E-39005 Santander, Spain, MASSIMILIANO STENGEL, Institut de Ciència de Materials de Barcelona (ICMAB-CSIC) Campus UAB, E-08193 Bellaterra, Barcelona, Spain — Capacitors are ubiquitous in solid state devices like metal oxide semiconductors field effect transistors (MOSFET). For energy efficiency, the MOSFET should operate at small gate voltages. In this regime, to increase the channel conductivity and performance, the capacitance of the capacitor between the gate and the channel should be made as large as possible. Recently, an enhancement of the capacitance of upto 40 % with respect this classical limit has been reported in two-dimensional electron gases formed at the interface between two oxides, $SrTiO_3$ and $LaAlO_3$. A first theoretical analysis pointed to the quantum exchange-energy in the electron-electron interactions as the driving force to explain the anomalous behavior. The exchange-interaction would produce a lowering of the chemical potential of the electron system as the electronic density increases (the negative compressibility effect). Here we test the validity of the approach, carrying out self-consistent calculations on a capacitor where the metallic plates are simulated by a jellium. We study the effect of the thickness of the metallic electrode and the density of the free electron, on the spillage of the electronic clouds into the dielectric and the variation of the chemical potential.

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