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Fast response time of electron plasma in high electron mobility transistor channels GREG RUPPER, SERGEY RUDIN, U.S. Army Research Laboratory, MICHAEL SHUR, Rensselaer Polytechnic Institute, MEREDITH REED, U.S. Army Research Laboratory — We report on the theoretical studies of the response of the two-dimensional gated electron gas to a voltage step applied at the gate. The results are given for numerical solution for a non-linear hydrodynamic model as well as the analytical solution for the linear hydrodynamic model. Both models include the effects of pressure and viscosity and are valid for all mobilities. For low mobility samples, such that $\omega_{\mathrm{p}}\ \tau <<1$, where ω_{p} is the plasma frequency and τ is the momentum relaxation time, the solutions in the frame of the hydrodynamic model of non-linear plasma transport predict the decay time of $4\mathrm{L}^2/(\ \pi^2\mu\mathrm{U})$, μ is the mobility, U is the gate voltage swing, and L is the channel length. For high mobility samples, such that $\omega_{\mathrm{p}}\tau >>1$, the drain voltage response oscillates with a decaying magnitude. The period of the oscillations is on the order of the plasma wave transit time (4L/s where s is the plasma velocity). The decay time of the oscillations is determined by the momentum relaxation time and the viscosity of the electronic two dimension gas (fluid). We find that the oscillating period is much shorter than the electron transit time $\mathrm{L}/\mathrm{v}_{\mathrm{d}}$ (v_{d} is the electron drift velocity), which is used as a conventional figure of merit for the device speed. These results are important for developing a new generation of terahertz electronic devices and comparing different materials systems for their potential of reaching ultimate switching speed and/or the highest frequency of operation

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