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Multiphysics model of semiconducting ferroelectrics and its application to memory devices NATHANIEL NG, KAUSHIK BHATTACHARYA, California Institute of Technology — Ferroelectrics are used in many electronic devices, in particular as transistors for ferroelectric memory devices. The behavior of these materials are often described via the classic time-dependent Ginzburg Landau model, where they are treated as insulators. However, it is well known that ferroelectrics are in fact wide band-gap semiconductors. It then follows that capturing the key aspects of semiconductor physics–band bending at the interface, Fermi levels, depletion layers, require ferroelectrics to be treated as semiconductors. In this work, we introduce a model that addresses these difficulties, yet at the same time is consistent with both the time-dependent Ginzburg Landau model and the classic drift-diffusion model in semiconductors. Unlike other models, our model makes no a priori assumptions on the space charge and polarization distributions and is not restricted to equilibrium profiles. We first demonstrate that charge carriers migrate to neutralize electric fields across 90° domain walls. Finally, we attempt a full simulation of a ferroelectric transistor and model current flow, electric field and polarization distributions.

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