Fabrication and Device Simulation of a 0.1 um MOSFET with an Abrupt Retrograde Channel Profile

As devices channel lengths evolve into the tenth micron regime, substrate doping levels on the order of 10^{18} cm^{-3} are required to eliminate short channel effects. This level of doping, however, leads to an unacceptable large threshold voltage since gate oxide thickness must be of sufficient thickness to prevent gate oxide tunneling currents. Retrograde channel doping profiles with acceptable gate oxide thickness and short channel performance have been reported using high energy implants. However, it has been found that retrograde high energy channel implants are not abrupt enough to suppress short channel effects in 0.1 um or below channel length Mosfets. Two-dimensional computer simulations are presented of the fabrication processes and device characteristics of a 0.1 um Mosfet with an abrupt retrograde channel implant that results in improved short channel effects. The fabrication process utilizes conventional CMOS processing that incorporates an undoped epitaxial channel growth process. The Athena process simulation program was used to generate the vertical cross-sections and doping profiles of the fabrication process. The completed retrograde device structure was then imported into the Atlas device simulation program. Simulation results are presented of fabrication processes, impurity doping profiles and the process-device tradeoffs associated with the retrograde channel profile and suppression of short-channel effects.