Electron Inversion Layer Mobility in Strained-Si *n*-MOSFETs with High Channel Doping Concentration Achieved by Ion Implantation

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Inversion layer mobility measurements in strained-Si *n*-MOSFETs fabricated using a typical MOSFET process including high temperature steps and with various channel doping concentrations, achieved by boron ion implantation, are compared with co-processed bulk-Si *n*-MOSFETs. It is found that a near-universal mobility relationship with vertical effective electric field, E_{eff}, exists for strained-Si and bulk-Si *n*-MOSFETs for all channel implant doses in this study. Significant mobility enhancement for E_{eff} up to 2 MV/cm (1.5-1.7 x) is obtained for channel doping concentrations ranging from 10^{17}-$6x10^{18}$ cm^{-3}.

Long-channel *n*-MOSFET devices were fabricated and measured with various ion implant doses in strained-Si and bulk-Si (unstrained) channels. The devices were fabricated using a typical MOSFET process including high temperature steps of gate oxidation and reoxidation at 800° C and a 1000° C spike anneal for source/drain and polysilicon-gate doping activation. Electron mobility measurements on 50x50 μm^2 *n*-MOSFETs with oxide thickness of 5 nm were extracted for boron ion implant concentrations in the range 10^{17}-$6x10^{18}$ cm^{-3} as shown in Figure 42. Significant mobility enhancement for all channel doping concentrations for the entire E_{eff} range measured (1.5-1.7 x) are observed. Furthermore, a near-universal mobility relationship with E_{eff} is found. The conclusion from this study is that strained-Si *n*-MOSFETs, with channel doping concentration required to meet the off-current requirement for the ITRS 40 nm technology node (L_{gate}=28 nm), can be fabricated with little if any loss of low-field mobility enhancement using conventional MOSFET processes with ion-implanted channels and high temperature steps.

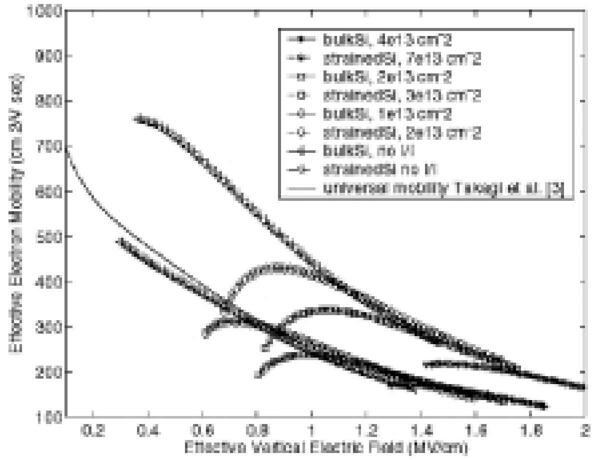

Fig. 42: Effective electron mobility in strained-Si and bulk-Si n-MOSFETs vs. effective vertical electric field, E_{eff} for varying channel doping concentrations.