Enhanced CHISEL Programming in Flash Memory Devices with SiGe Buried Layer

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In flash memory devices, channel initiated secondary electron (CHISEL) injection offers a lower voltage and lower power programming mechanism in comparison to other mechanisms such as channel hot electron (CHE) injection or Fowler-Nordheim tunneling [1]. CHISEL programming relies on the injection of carriers created by secondary impact ionization (SII) into the floating gate; so, the CHISEL gate current is directly proportional to the SII rate. Placement of a SiGe buried layer such that the interface between the SiGe layer and the Si cap layer is in the region of peak SII activity increases the SII rate and therefore enhances the CHISEL gate current in NOR flash electrically erasable and programmable read-only memory (EEPROM) devices. Both electrical characterization of physical devices (planar NOR flash EEPROM with SiGe nanocrystal floating gate) and device simulation show at least a 2-3X enhancement in CHISEL programming when a buried SiGe layer is present [2]. This enhancement as well as results showing the optimal depth of the interface and the effects of varying the Ge concentration in the buried layer are presented.

[1] N. Mohapatra, D. Nair, S. Mahapatra, V. Rao, S. Shukuri, and J.D. Bude, "CHISEL Programming Operation of Scaled NOR Flash EEPROMS—Effect of Voltage Scaling, Device Scaling, and Technological Parameters," *IEEE Transactions on Electron Devices*, vol. 50, no. 10, October 2003.

[2] D.L. Kencke, X. Wang, Q. Ouyang, S. Mudani, A. Tasch Jr., and S.K. Banerjee, "Enhanced Secondary Electron Injection in Novel SiGe Flash Memory Devices," *IEDM 2000*, 5.4.1.