Increased flicker noise with increasing Ge concentration in the virtual substrate of strained Si surface channel n-MOSFETs

K. Fobelets[1], S.L. Rumyantsev[2], S.H. Olsen[3], and M.S. Shur[2]
[1]Imperial College London, UK. [2]Rensselaer Polytechnic Institute, USA. [3]Newcastle University, UK.

Strained-Si surface channel n-MOSFETs grown on relaxed virtual substrates (see Fig.1) with a Ge concentration varying between 0% and 30% have been investigated. An increased Ge concentration results in higher carrier drift mobility, increasing from 380 $cm^2V^{-1}s^{-1}$ for the unstrained channel to 865 $cm^2V^{-1}s^{-1}$ for the strained-Si MOSFET on 30% relaxed SiGe virtual substrate. However, the higher mobility is traded off for increased substrate leakage currents and increased 1/f (flicker) noise (see fig.2). This increase in noise might negatively impact prospects for applications of this devices, and therefore, studies of the 1/f noise and its mechanism in these structures is of interest. It is suggested that the increase in the flicker noise is due to the increased concentration of traps in the oxide layer, possibly due to the diffusion of Ge into the active layer and oxide during gate oxidation, as also evidenced by measured current-voltage characteristics. The density of traps was extracted using the McWhorter model, which links the MOSFET noise to the fluctuations of the electron density caused by traps in the gate dielectric layer. This density increases from 2 10^{17} $eV^{-1}cm^{-3}$ to 2.3 10^{18} $eV^{-1}cm^{-3}$ with the increase in Ge composition in the virtual substrate from 0% to 30% Ge. These results clearly indicate the role of the Ge concentration in the substrate in determining the 1/f characteristics of the strained-Si n-MOSFETs.

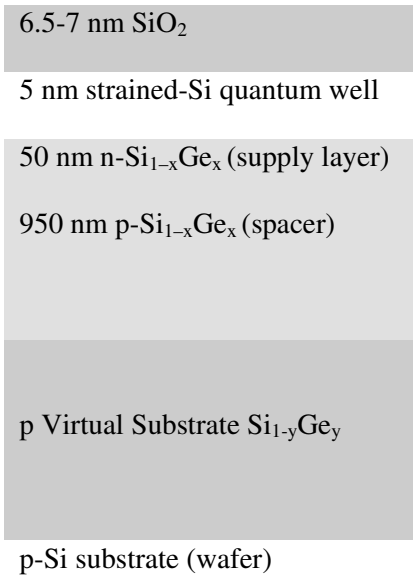

Fig.1. Schematic layer structure of the strained-Si surface n-channel MOSFETs with x = 10, 15, 20, 25 and 30%.

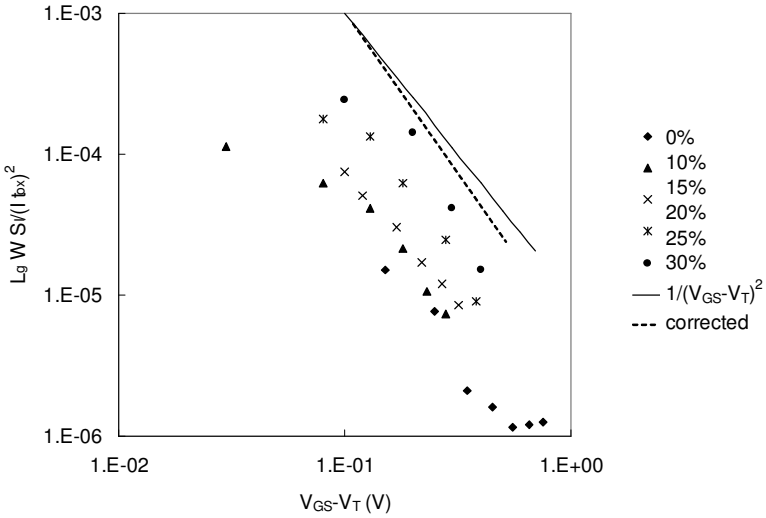

Fig 2: Normalised relative spectral noise density at 10Hz as a function of gate voltage overdrive. Full/dashed (corrected for contact resistance) lines show the expected slope above threshold in accordance with the McWhorter model.