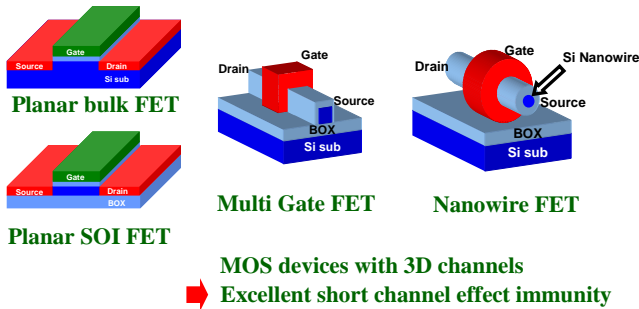


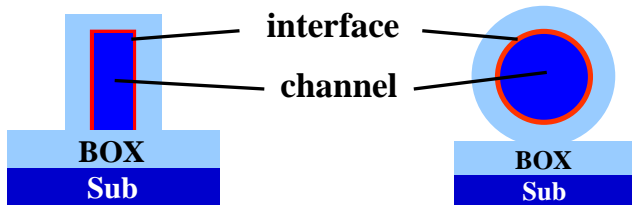
Interface State Density Measurement of Three Dimensional Silicon Structures by Charge Pumping Method

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Background



A promising Device to replace planar Si MOSFET



3D channel consists of several or more crystallographic orientation formed by etching or oxidation process.

One of the concerns with these structures is the presence of interfacial state density (D_{it}), which is strongly dependent on the surface orientations.

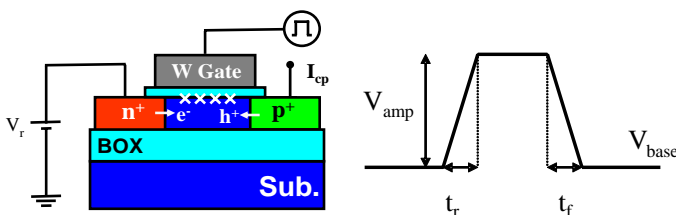
Purpose

Direct measurement of cross-sectional shape dependent- D_{it} and its distribution in the energy gap is needed.

Characterization Charge Pumping Method

Charge pumping method has been applied to 3D structures fabricated on a SOI wafer by forming gated PIN diodes.

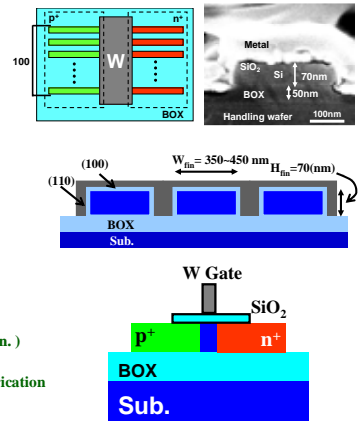
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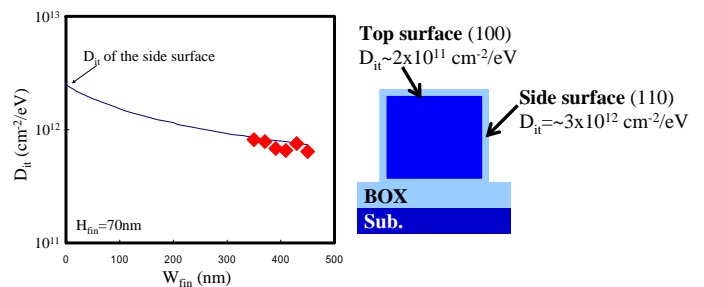
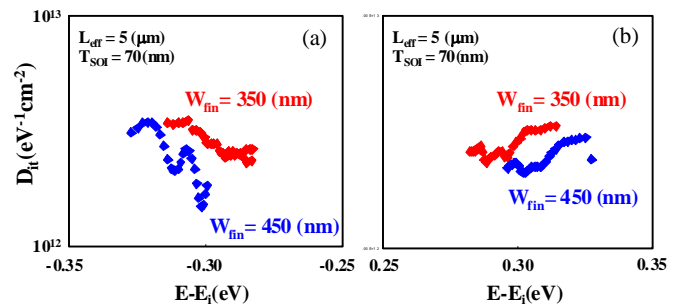
Charge pumping current (I_{cp}) measurements were performed by changing the rise (t_r) and fall time (t_f) parameters of the trapezoidal pulse waves applied to the gate electrode.

Experimental Method

- 1 Fin Patterning (Lithography and RIE Etching)
Wafer: p type SOI wafer (100)-oriented SOI (70nm)/ BOX (50nm)
Line structures (fin) ranging from 350 to 450 nm in width
- 2 Thermal Oxidation(1000 , 10min)
- 3 W deposition (RF magnetron sputtering)
- 4 Ions implantation (Phosphorus, 30keV, $3 \times 10^{14} \text{ cm}^{-2}$)
- 5 Ions implantation (BF₂, 30keV, $3 \times 10^{14} \text{ cm}^{-2}$)
- 6 Activation annealing in N₂ gas (800°C, 5min.)
- 7 Al contacts at source and drain regions fabrication (thermal evaporation)
- 8 F.G. annealing (420°C, 30 min)



Results



Conclusions

Interfacial state density of three dimensional Si channels with a rectangular cross section has been measured by charge pumping method using gated PIN diodes formed on an SOI wafer.

An increase in the D_{it} has been observed with narrower fin structures. It can be modeled that D_{it} can be estimated by the average D_{it} of top and the sidewall surface, in proportion to the channel width.

Acknowledgment

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