Scaling Effects in Air Gap MOSFET

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Introduction:This poster addresses the effect of scaling in air gap MOSFETs. COMSOL was used for modelling and simulations. An air Gap MOSFET is one obtained by replacing the dielectric in a MOSFET with air. The air gap between the gate and the channel allows the gate to deflect when a load acts upon it. A MOSFET such as this would be the sensing element of a Hydrophone.

Computational Methods :Two domains of physics were used in the simulation namely
1)Electrostatics
2)Convection and diffusion(for holes & electrons)
Simulations were carried out for different air gaps and doping concentrations. The effect of the change in air gap and doping concentrations on the drain current were studied, by plotting the Id(drain current) vs Vd(drain voltage) curve for each case.
The typical equation for the drain current in MOSFET is given by

$$I_D = \frac{W\mu_n C_{ox}}{L}\left[(V_G - V_{th})V_D - \frac{V_D^2}{2}\right]$$

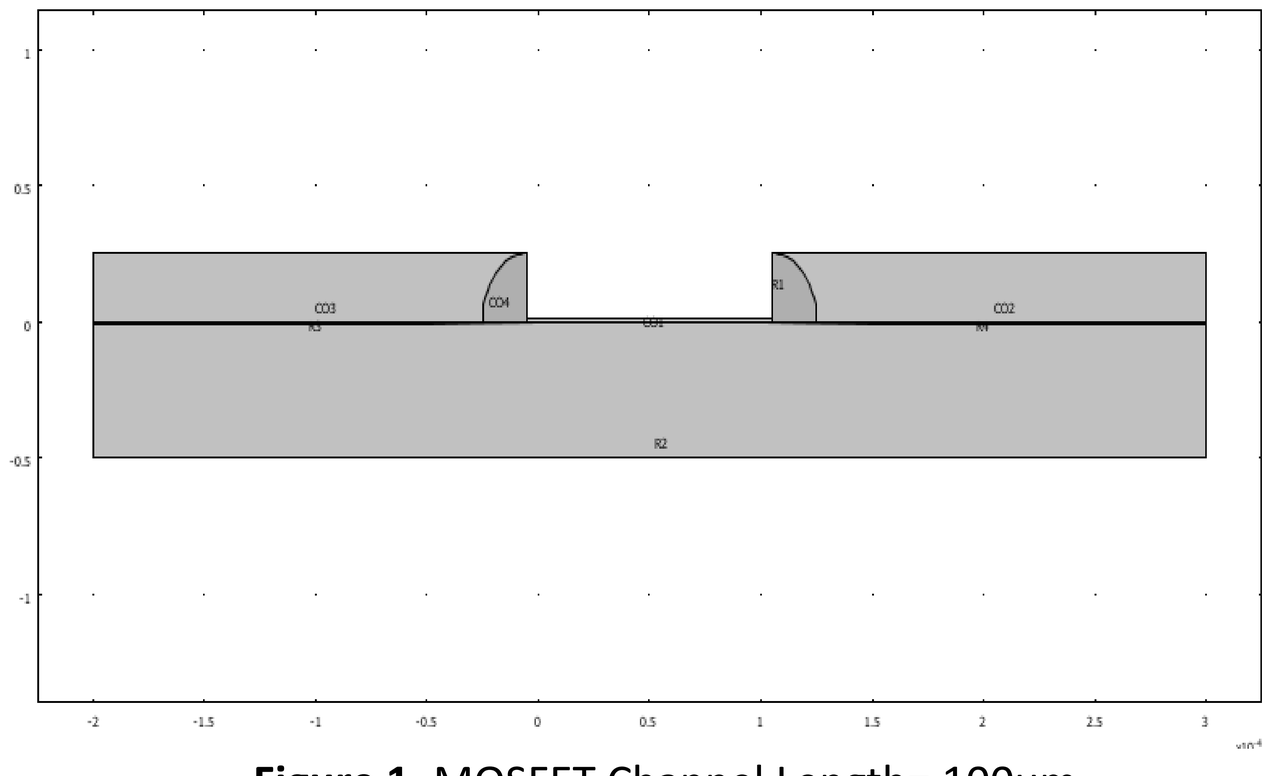

Figure 1. MOSFET Channel Length= 100um
Air-gap= 1um

Results:

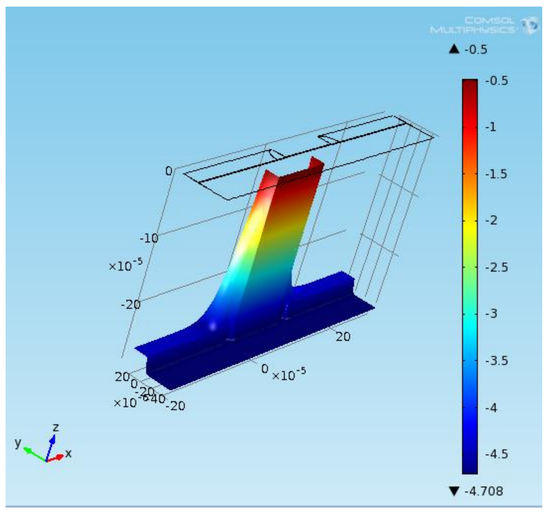

Figure 2.Electric potential on different regions of the MOSFET

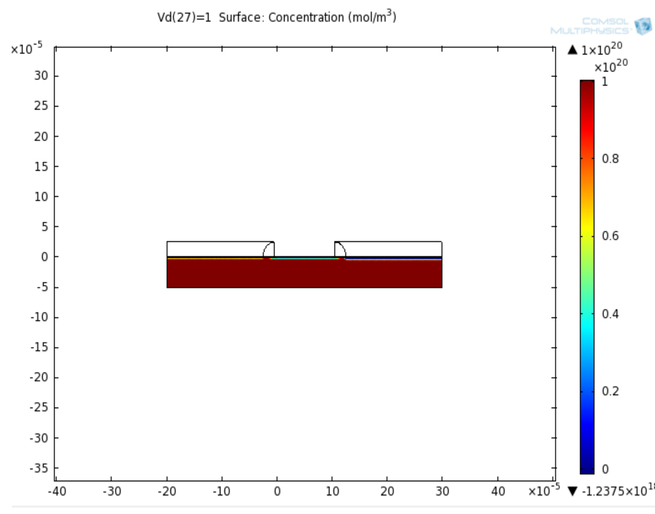

Figure 3. Concentration gradient

Variable	Base Value	Range	Units
Air Gap	1	0.25-10	um
Doping for implanted profile	1.2	1.2-10	cm^3 (*1e14)
Gate Length	100	100-1000	um
Gate Voltage	15	computed	V

Table 1. Range and list of scaled parameters

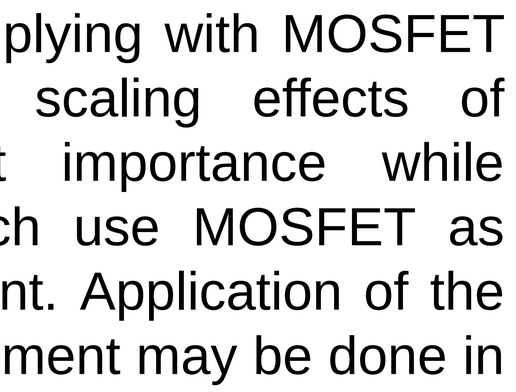

Figure 4. Typical graph for Id vs Vd

Conclusions:
Variation of Id was observed on changing the various parameters within a specified limit.
It was observed that Id increases with decrease in the air gap-results complying with MOSFET physics. The study of scaling effects of MOSFET is of utmost importance while designing sensors, which use MOSFET as their basic sensing element. Application of the MOSFET as a sensing element may be done in pressure, temperature and humidity sensors using similar principles as described above.

References:
Reference Book
1)Solid State Electronic Devices
Author: Streetman