2.2 Punchthrough

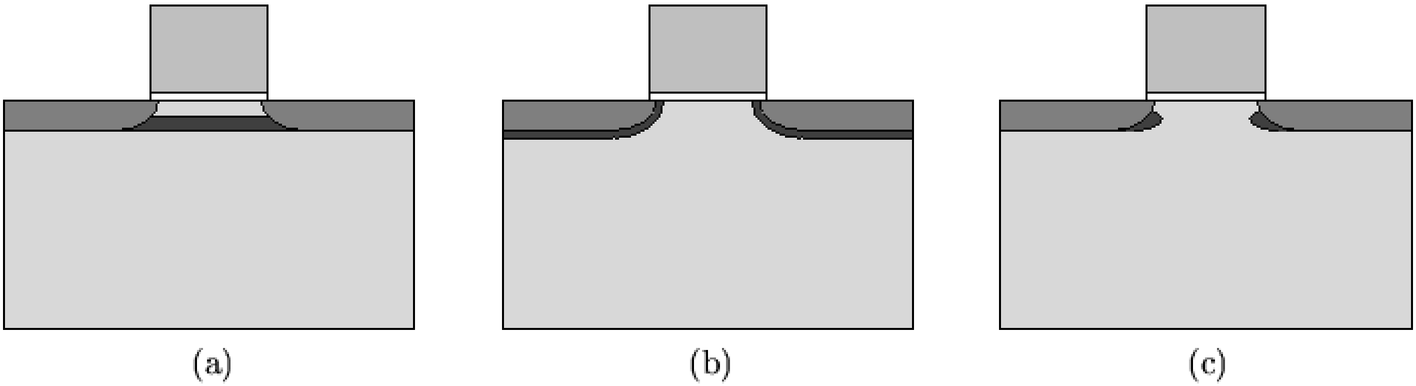
As already mentioned in Section 2.1, the drain current of a MOS transistor will increase in some cases in which a parasitic current path exists between drain and source. This part of the drain current is poorly controlled by the gate contact since the current path is located deeper in the bulk, farther away from the gate. It adds to the subthreshold leakage current leading to an increased power consumption. Therefore, punchthrough should be avoided whenever possible.

The actual amount of punchthrough current depends mainly on the potential distribution under the channel. If the depletion area around the drain well extends too far to the source side, as shown in Fig. 2.2 for Device α, the potential barrier between source and drain will be lowered and carriers will start to move from source to drain (see Fig. 2.3). Therefore, punchthrough highly depends on the applied drain voltage and on the source/drain junction depths.

A simple way to reduce the punchthrough effect is to increase the overall bulk doping level. As a result the drain and source depletion regions will become smaller and will not establish a parasitic current path. Since a higher bulk doping increases the subthreshold swing at the same time as explained in Section 2.1, this method is not the most efficient one to reduce drain-source leakage.

Other methods to prevent punchthrough which have almost no effect on the subthreshold swing are depicted in Fig. 2.5. They make use of spatially restricted dopand implantations like (a) delta doping, (b) halo, or (c) pocket implants heading for a shield against punchthrough without affecting the subthreshold swing [74].

Figure 2.5: Advanced methods to prevent punchthrough using (a) delta doping, (b) halo, and (c) pocket implants.



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