

# FinFET

(E)

- A bulk-FinFET is a four-terminal device with gate, source, drain, and substrate or body.
- A FinFET can be designed on a bulk-Silicon substrate or SOI-substrate.
- A FinFET device is symmetrical & cannot be distinguished without applied bias.

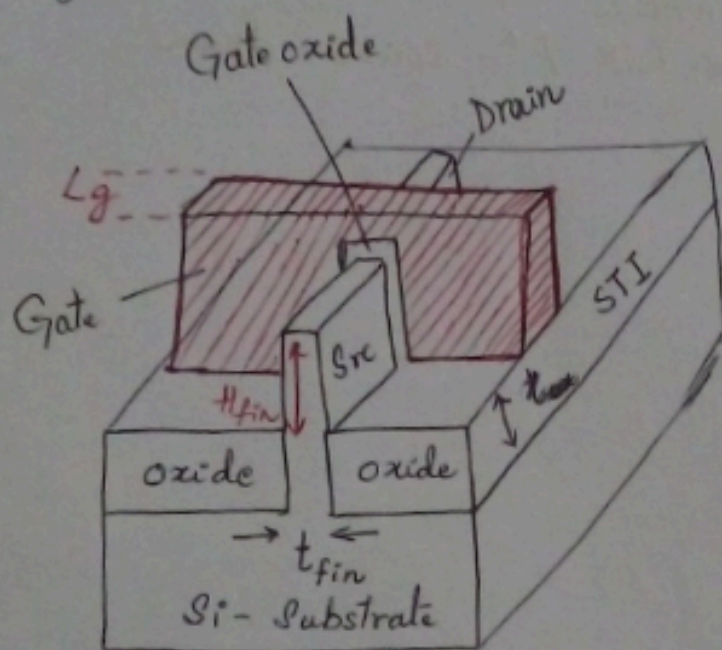
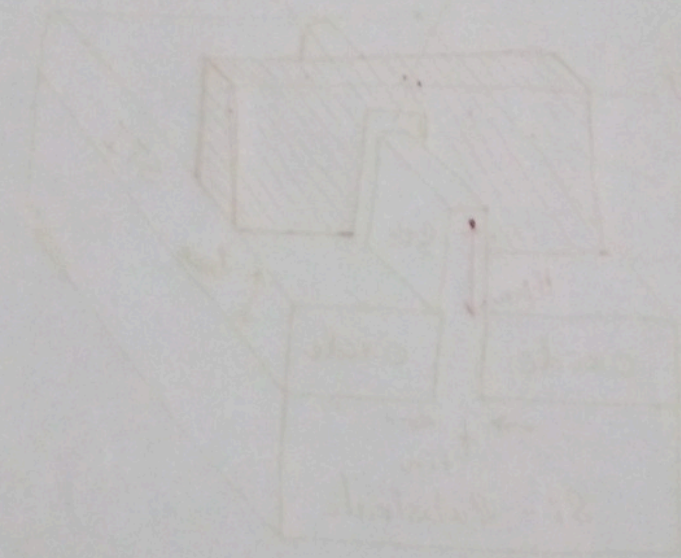


fig: 3-D FinFET device structure

- Figure shows ideal 3-D FinFET device structure.
- The FinFET has a ultrathin vertical Silicon body, called the FIN, on silicon pedestal, sidewall gate stack, and a source and a drain at the two ends of the gate length.
- The source & drain regions are heavily doped.
- The gate electrode is a conducting metal layer grown on thin insulating layer such as  $\text{SiO}_2$ .



- The gate can be placed on two, three, or four sides of the channel or wrapped around the channel.
- STI (Shallow Trench Isolations) are used to isolate various devices fabricated on the same substrate.
- There are two types of FinFETs
  - a)  $n$ -channel FinFETs
    - $p$  type Fin with  $n^+$  source-drain
  - b)  $p$ -channel FinFETs
    - $n$  type Fin with  $p^+$  source-drain





## FinFET

- In 1999, the concept of FinFET was proposed by Berkeley Professor Chenming Hu.
- The main principle behind the FinFET str is a thin body, so gate capacitance is closer to whole channel.
- The body is very thin, around 10nm or less. So, there is no leakage path which is far from the gate. The gate can effectively control the gate leakage.
- In FinFET, the channel is controlled by more than one side of channel.
- Modern FinFETs are 3D structures, also called tri-gate transistors.
- FinFETs can be implemented <sup>either</sup> on bulk Si or SOI Wafer.
- The FinFET str consists of thin (vertical) fin of Si body on a substrate.
- The gate is wrapped around the channel providing excellent control from three sides of the channel.
- This str is called FinFET  $\therefore$  its Si body resembles the back fin of a fish.
- In bulk-Mos, the channel is horizontal. While in FinFET channel, it is vertical. So for FinFET, the height of the channel (Fin) determines the width of the device.

$$\text{Width of the channel} = 2 \times \text{Fin Height} + \text{Fin Width}$$



- (H) (4)
- The drive current of the FinFET can be increased by increasing the width of the channel i.e., by increasing the height of the fin.
  - We can also increase the device drive current by constructing parallel multiple fins connected together.
  - In FinFET, the gate str is wrapped around the channel and the body is thin, providing better short channel effects (SCE).
  - FinFET suffers less from dopant induced variations.
  - Low channel doping also ensures better mobility of the carriers inside the channel. Hence, higher performance.
  - FinFET technology provides numerous advantages over bulk CMOS, such as
    - a) higher drive current
    - b) Lower leakage
    - c) higher speed
    - d) Lower power consumption
    - e) better scaling