

PNP Transistor Fabrication

What are the three major methods to dope a semiconductor with doping impurities?

Historically, which of these methods is the oldest method?

What is currently the most common method to dope Si?

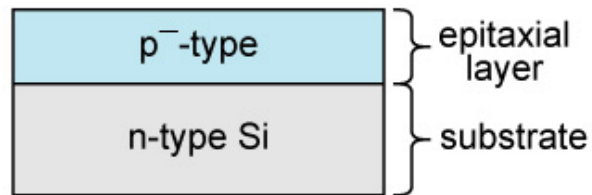
Why is the oldest method used rarely in Si technology at the present time?

What are the advantages of the presently used method to dope Si?

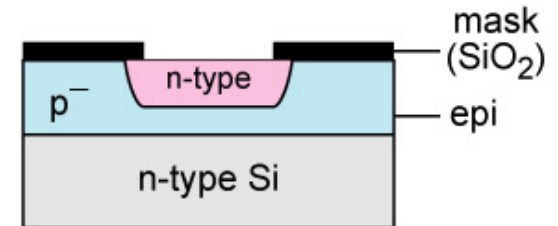
Diffused epitaxial transistor

Diffused epitaxial transistor

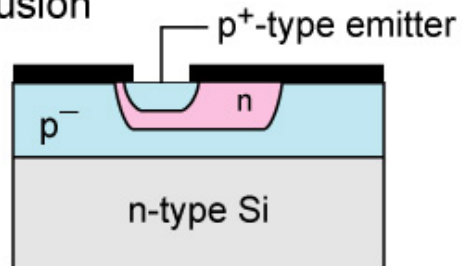
(1) Epitaxial wafer



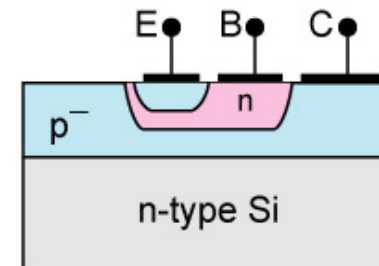
(2) Base diffusion



(3) Emitter diffusion

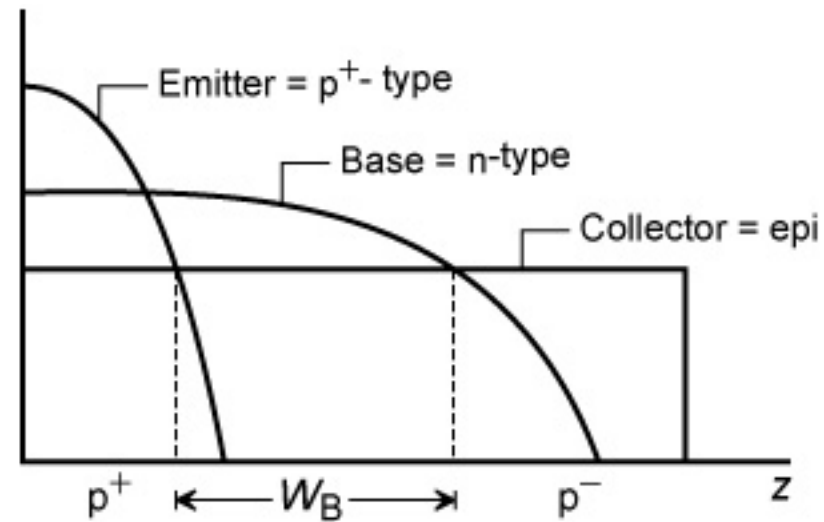
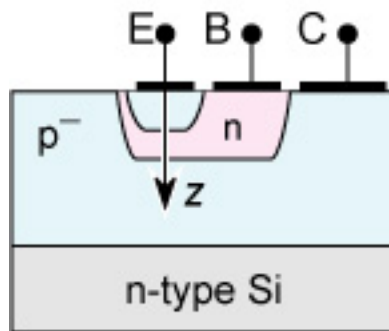


(4) Contacts



Doping profile

Doping profile



Disadvantage of this process: Collector must be p⁻

→ Collector has low conductivity

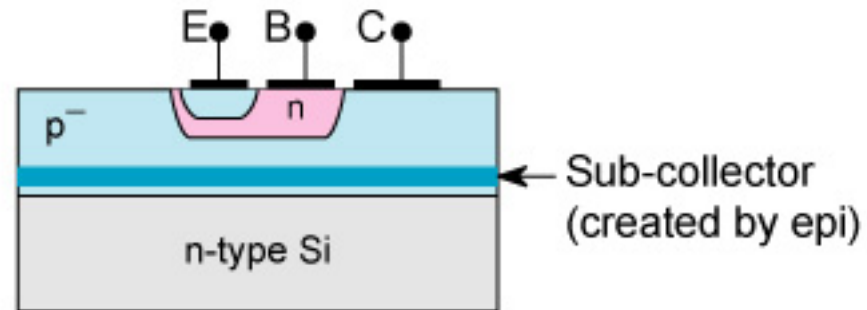
Why must collector in a diffused transistor be more lightly doped than base and emitter?

Why is low collector conductivity a disadvantage?

How would I - V change as collector resistance increases?

Diffused epitaxial transistor with p+ sub-collector

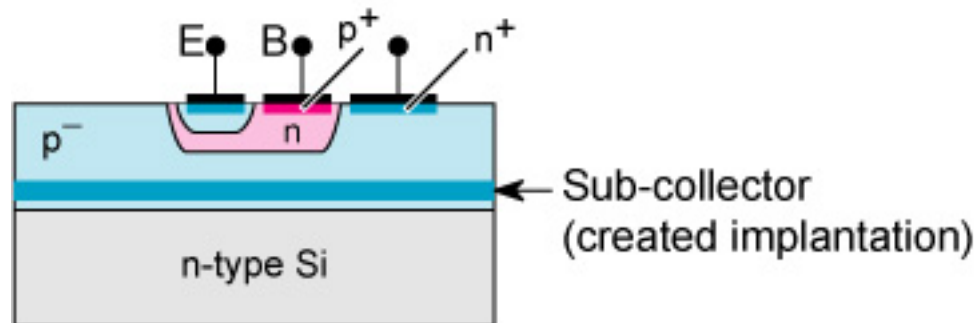
Diffused epitaxial transistor with sub-collector



Advantage: High collector conductivity

Implanted bipolar transistor

Implanted transistor with sub-collector



Advantage: Great flexibility by ion implantation n^{++} and p^{++} contacts

Today > 90 % of bipolar transistors are fabricated by ion implantation