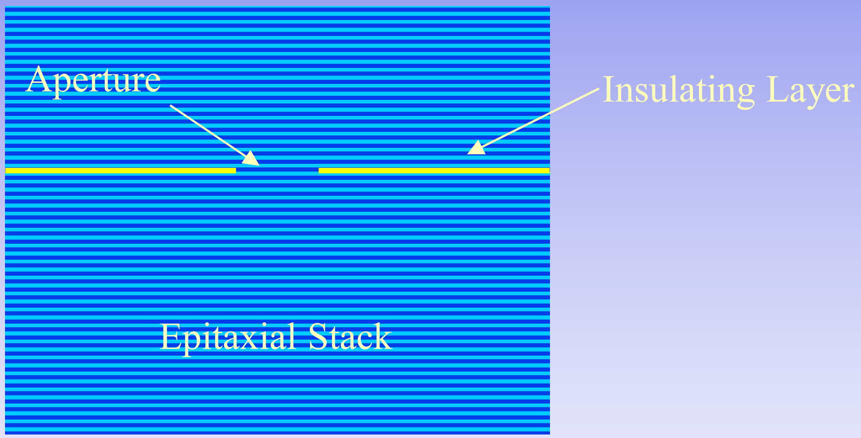
Lateral Wet Oxidation

Forms an insulating layer or an aperture in an epitaxial stack.
Oxidation starts from the edge of the stack and penetrates inward.



The layer that forms the aperture is typically AlGaAs with a high aluminum mole fraction.

Lateral Wet Oxidation of AlGaAs

- Works best in a high Al content $Al_xGa_{1-x}As$ layer.
  - Where $x > 0.95$
- Wet oxidation temperature of 350˚C to 450˚C is needed.
  - In the absence of oxygen
  - In carrier gas with water vapor
- Oxidized layer is composed mostly of Al_2O_3
  - As_2O_3 should diffuse out of the layer
  - Ga_2O_3 Stays

Common Knowledge

- Dry oxidation by O_2 forms dense α-Al_2O_3 on the surface that is a barrier to further oxidation.
- Wet oxidation by moisture forms porous γ-Al_2O_3 that continues to oxidize.
- Oxidation needs to be performed in the absence of O_2.
- Volatile As_2O_3 diffuses out of the layers.

Chemistry

Reaction of Aluminum with Water

$$2Al + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2$$
$$2Al + 4H_2O \longrightarrow 2AlO(OH) + 3H_2$$
$$2Al + 3H_2O \longrightarrow Al_2O_3 + 3H_2$$

From room temperature to 280˚C, $Al(OH)_3$ is most favored.
From 280 - 480˚C, $AlO(OH)$ is most favored (diaspore).
Above 480˚C, Al_2O_3 is the most favored product.

- As_2O_3 melts at 315ºC and boils at 465ºC
- It is soluble in water at 20 g/L (25 °C)

Experimental Observations

- An amorphous hydroxide region forms at the oxidation front first and visibly transforms to porous γ-alumina.
- A vertical contraction is 6% to 7% is observed when layers of 97% to 98% AlGaAs oxidize.
- Stress is reduced with dry annealing that allows byproducts to escape.
- Oxidation can leak into an adjacent high aluminum content layer, forming a wanted or unwanted tapered tip.