

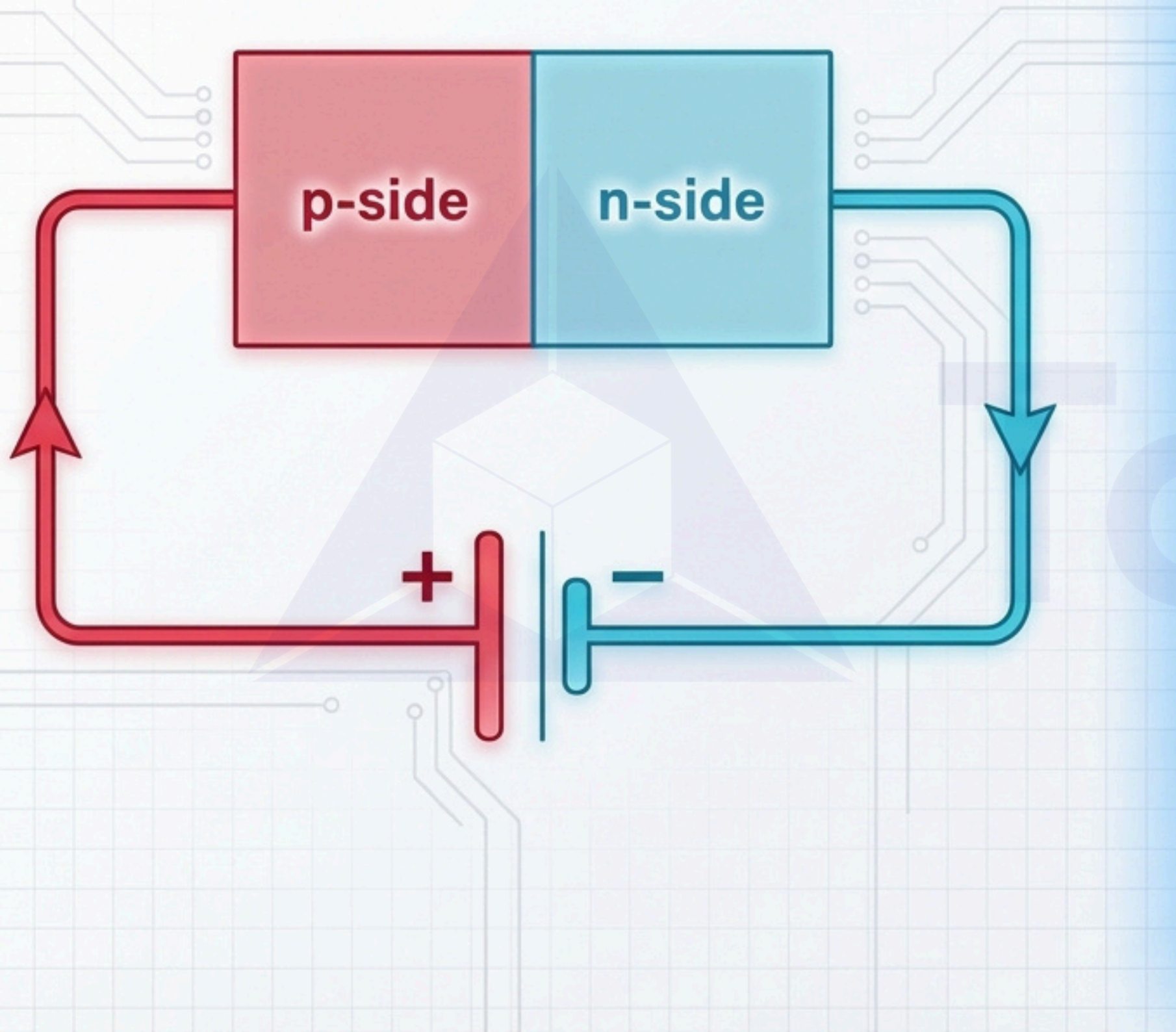
SEMICONDUCTOR ELECTRONICS: CHAPTER 14.6.1

p-n Junction Diode: Forward Bias

Understanding the dynamic physics of barrier reduction and minority carrier injection.

NEET/JEE High-Yield

Conceptual Explainer



The Forward Bias Connection

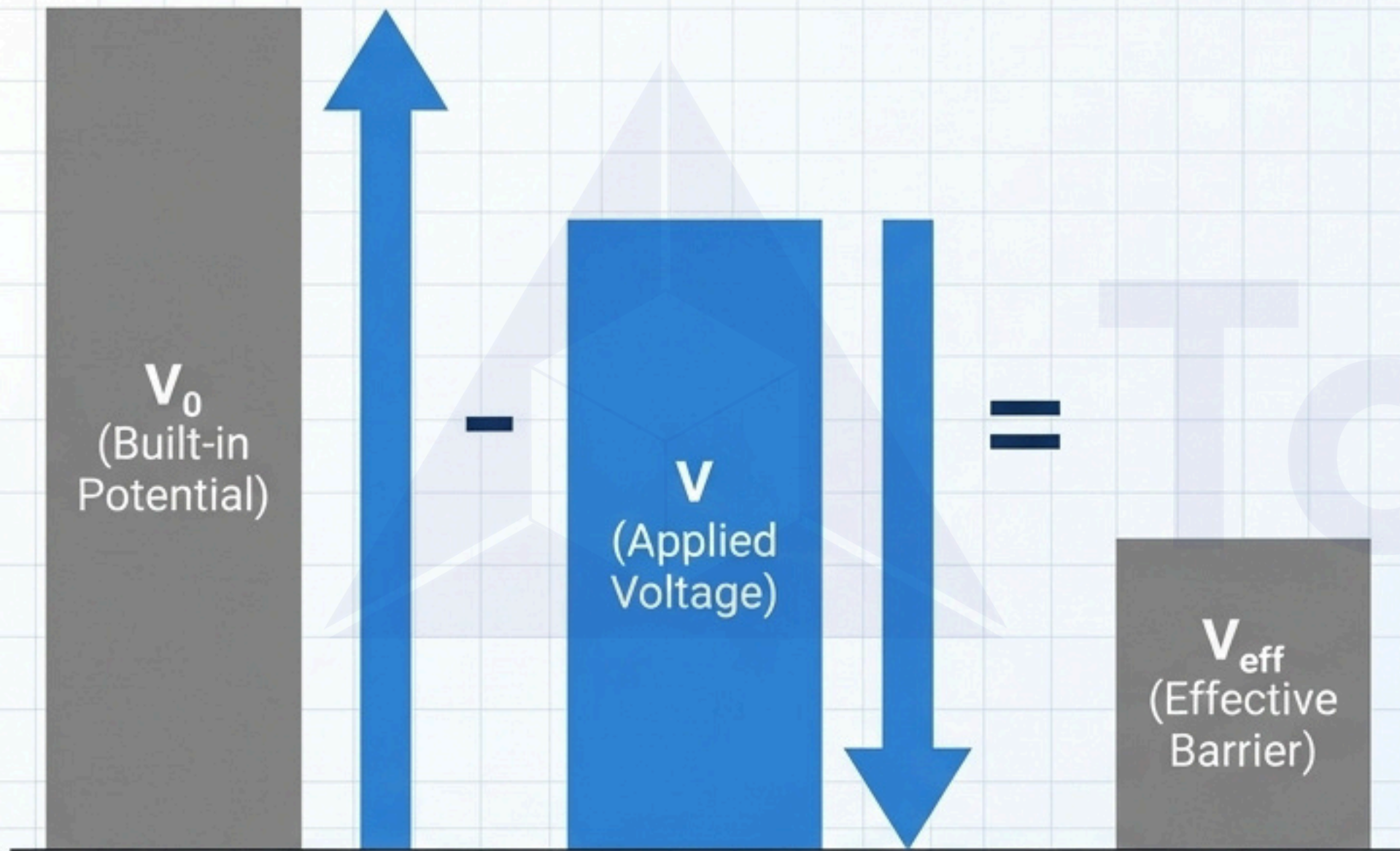
To forward bias a diode, the **p-side** is connected to the **positive** terminal, and the **n-side** is connected to the **negative** terminal.

Where does the voltage go?

➔ The applied voltage (V) mostly drops across the depletion region. The voltage drop across the bulk **p-side** and **n-side** is negligible because the depletion region has an exceptionally high resistance (no free charges).

Overcoming the Potential Barrier

$$V_{\text{eff}} = V_0 - V$$



The applied voltage strictly opposes the built-in potential. As the applied voltage increases, the effective barrier height is significantly reduced.

Lower Barrier → More carriers possess enough energy to cross the junction → Current increases



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$$E=mc^2$$



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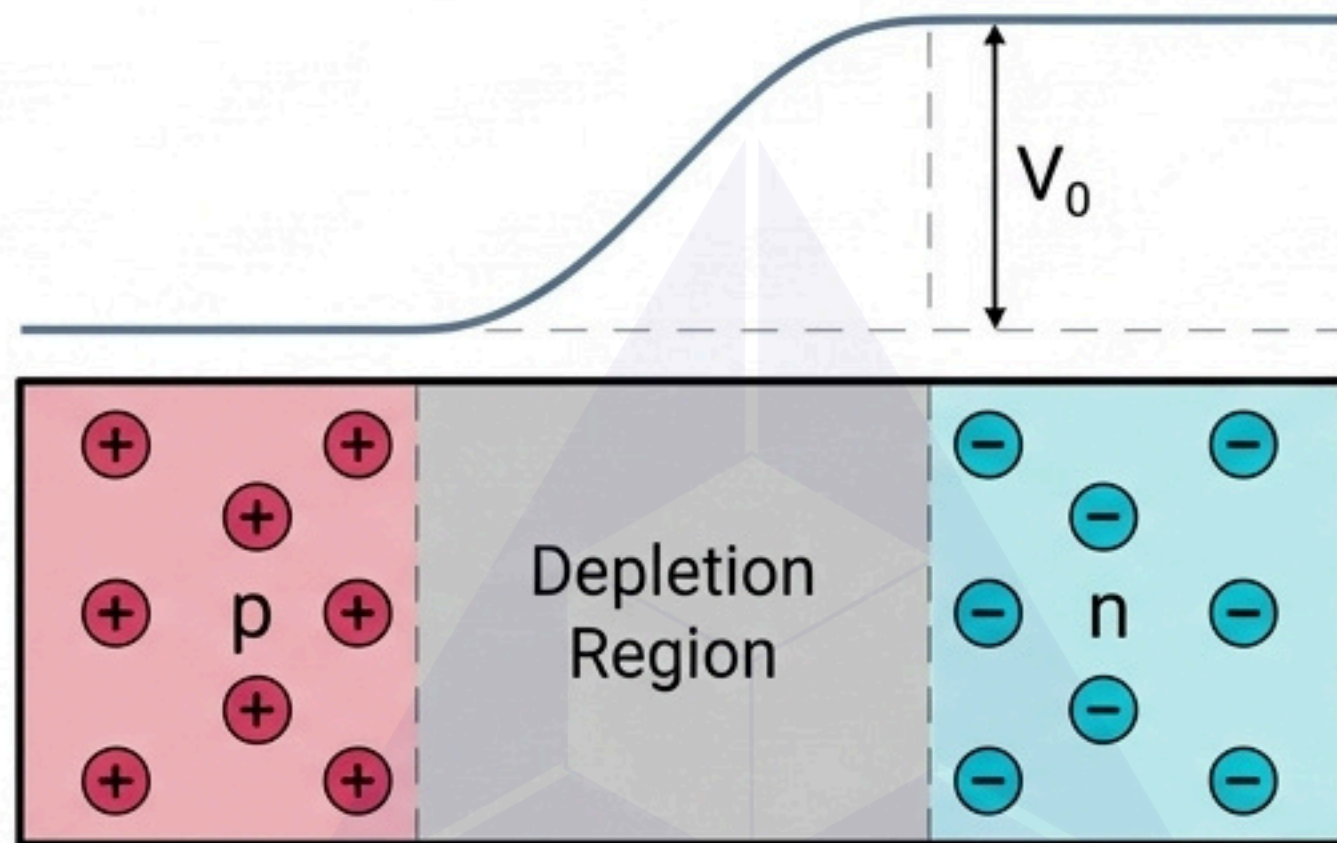
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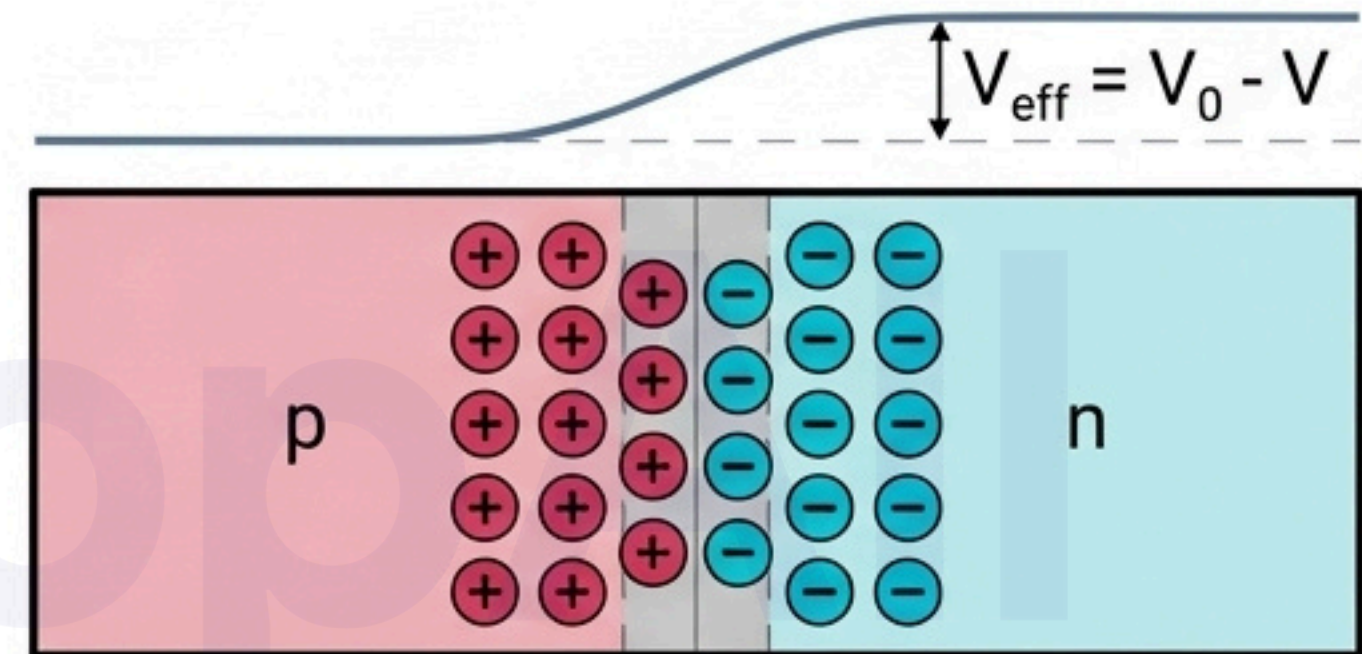
The Depletion Layer Shrinks

Equilibrium (No Bias)



Wide Depletion Zone.

Forward Bias

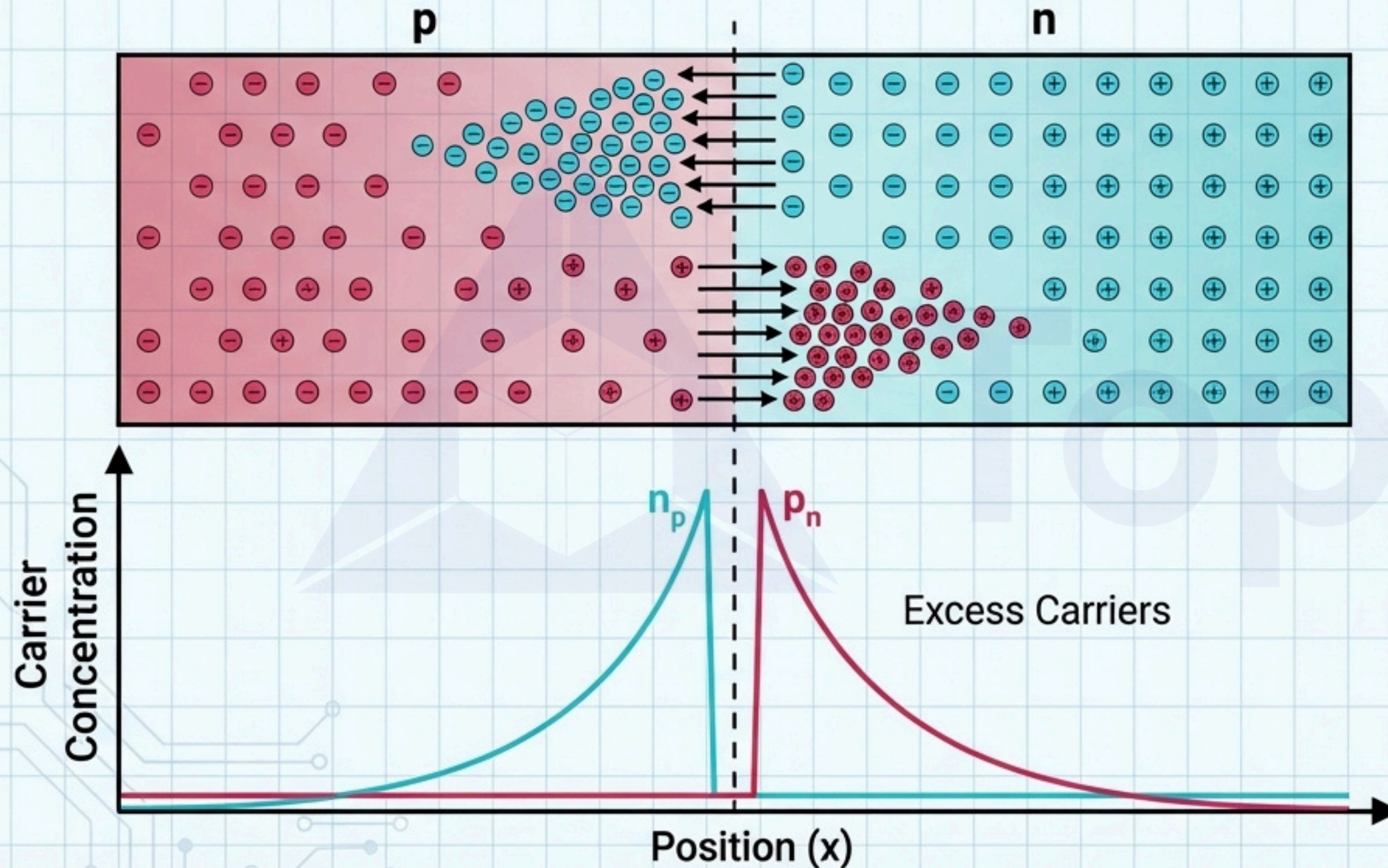


Narrow Depletion Zone.

Insight Text: The external electric field pushes majority carriers toward the center, actively narrowing the depletion region and allowing a path for current to flow.

Minority Carrier Injection

What is Injection? → Electrons cross to the p-side; holes cross to the n-side.

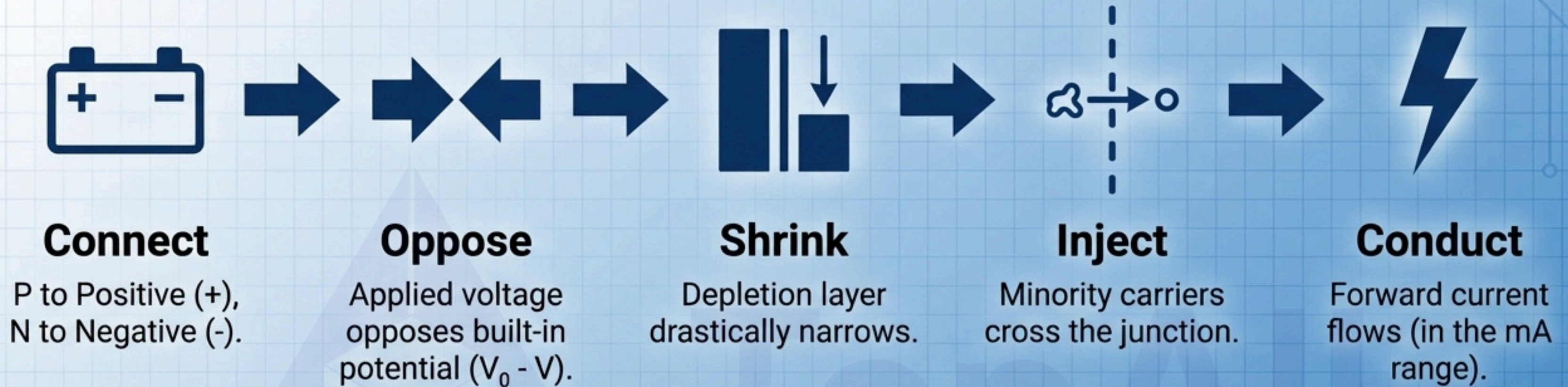


Injection Process

1. Carriers are injected across the lowered barrier.
2. Concentration spikes at the junction boundary.
3. Carriers diffuse away from the junction due to the concentration gradient.

Note: The total forward current is the sum of hole and electron diffusion currents (measured in mA).

The Forward Bias Chain Reaction



Key Takeaway

Forward bias reduces junction resistance, allowing a significant, exponential increase in current once the threshold voltage is crossed.



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