

# The $p$ - $n$ Junction Diode in Breakdown

If reverse bias too large (i.e.,  $v_D < -V_{ZK}$ ), the **covalent** bonds within the depletion region will **break**.

Therefore, **free** electrons are created (i.e., **conductivity**  $\sigma$  goes from zero to very high).

Large electric field **and** high conductivity:

 This means **high current** ( $J = \sigma E$ ) !!

Attempts to decrease  $v_D$  past  $-V_{ZK}$  instead just causes further breaking of covalent bonds (i.e., conductivity  $\sigma$  increases).

Therefore  $|i_D|$  increases while  $v_D \approx -V_{ZK}$ .

There are **two** mechanisms for breakdown.



**1) Zener Effect** - Covalent bonds break because of large **E**-field.



**2) Avalanche Effect** - Bonds break due to kinetic energy of drift current.