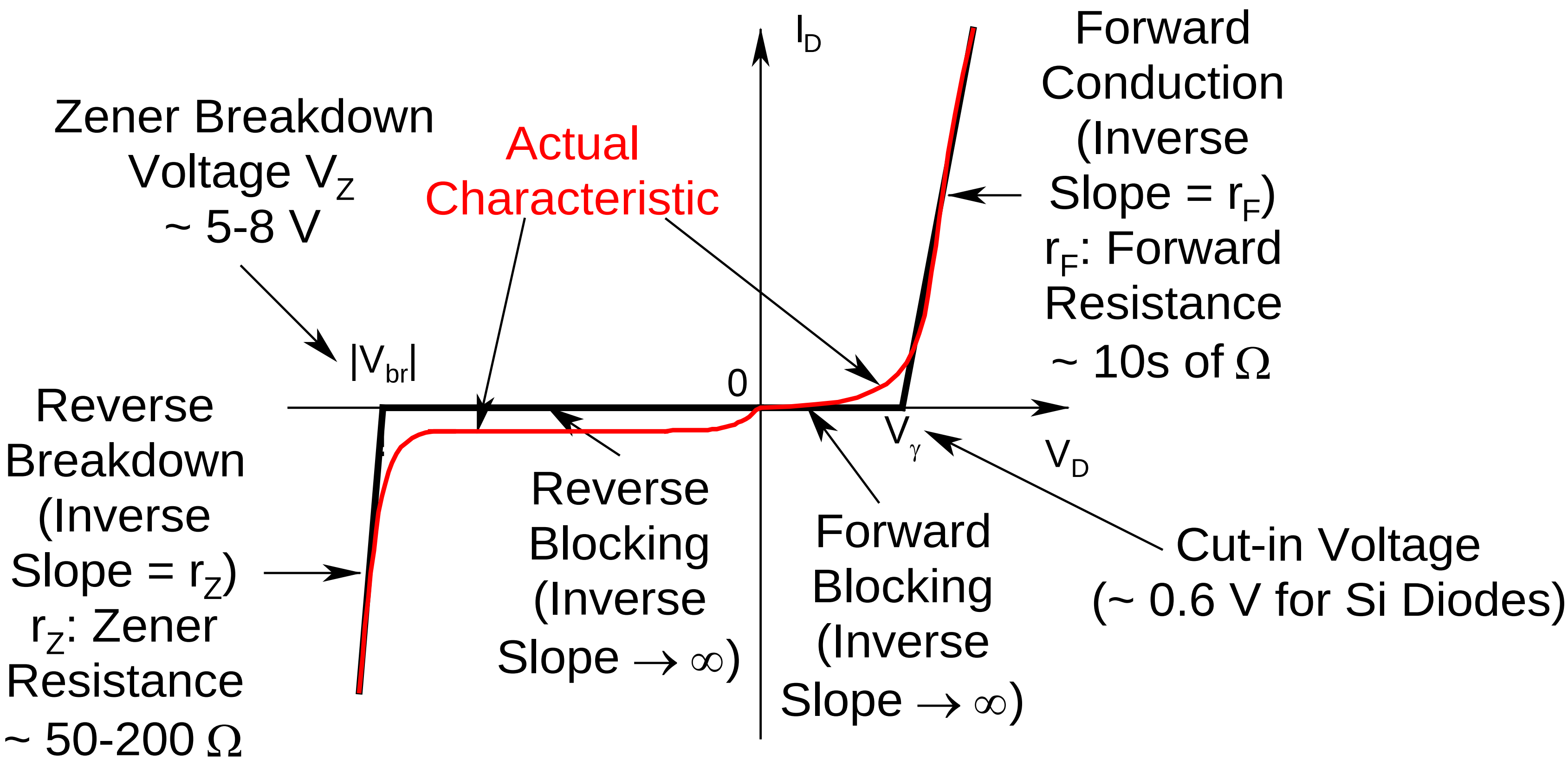
Reverse Breakdown

- ***2 Mechanisms***:
  - ***Zener***
  - ***Avalanche***
- ***Zener***:
  - ***For junctions with both sides very heavily doped***
  - ***Thin depletion region***, through which carriers ***tunnel through*** (***quantum mechanical process***)
  - ***Typical*** $|V_{br}| < 3\ V$

- ***Avalanche***:
  - ***Classical breakdown process***
  - ***At least one side must be lightly doped***
  - ***Carrier multiplication*** due to ***impact ionization***
  - ***Typical*** $|V_{br}| > 5$ ***V***
- For diodes having $|V_{br}|$ ***in between 3 V and 5 V***, ***a combination of these two processes***
- ***Breakdowns*** are generally ***destructive***, unless the ***current*** is ***controlled*** by ***external means***, e.g., by a ***resistor***

Piece-Wise Linear (PWL) Model



Note: The forward and reverse current scales are not same

PWL Regions

- $0 \leq V_D \leq V_\gamma$: ***Forward Blocking***
  - V_γ: ***Cut-in Voltage*** (~ ***0.6 V for Si diodes***)
  - $\boldsymbol{I_D = 0}$
- $V_D \geq V_\gamma$: ***Forward Conduction***
  - $\boldsymbol{I_D}$ ***increases linearly with*** $\boldsymbol{V_D}$ with an ***inverse slope of*** $\boldsymbol{r_F}$
  - r_F: ***Diode Forward Resistance*** (~ 10s of Ω) $= [dI_D/dV_D]^{-1}$

- Diodes under ***forward bias*** and for $V_D \geq V_\gamma$, offer ***small resistance*** (results from the ***exponential*** I-V characteristic)
- V_D negative and $0 \leq |V_D| \leq |V_{br}|$: ***Reverse Blocking***
  - ➢ $I_D = 0$
- V_D negative and $|V_D| \geq |V_{br}|$: ***Reverse Breakdown***
  - ➢ ***$|I_D|$ increases linearly with $|V_D|$*** with an ***inverse slope of r_Z***

- r_Z: ***Zener Resistance*** (~ 50-200 Ω)

  $= [d|I_D|/d|V_D|]^{-1}$

- Diodes under ***reverse bias*** and for $|V_D| \geq |V_{br}|$, offer ***small resistance***

  $\Rightarrow$ ***If current is not controlled by external means, then it may damage the device completely***

- Generally, diodes, unless they are to be operated in ***breakdown mode***, e.g., in a ***voltage regulator***, have ***very high*** $|V_{br}|$, typically of the order of ***100s of V***