# EE143 – Fall 2016
# Microfabrication Technologies

## Lecture 11: Design Rules and Layout
## Reading: Jaeger Chap. 9.2.2-9.2.4

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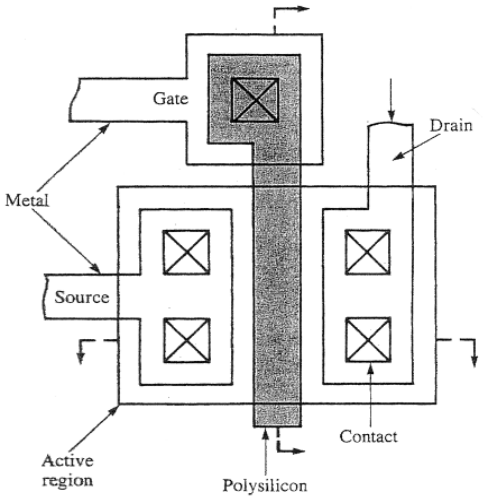
## Design Rules

- **Interface between designer and process engineer**
- **Guidelines for constructing process masks**
- **Unit dimension: Minimum line width**
  - **Scalable design rules: lambda parameter**
  - **Absolute dimensions (micron rules)**



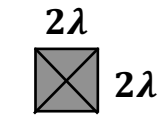
# Layout Design Rules

1) **Absolute-Value Design Rules**
   - **Use absolute distances**
2) **λ -based Design Rules**



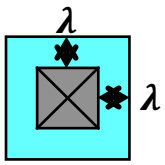



# Metal-Si Contact Hole

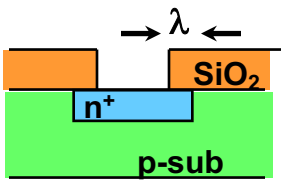


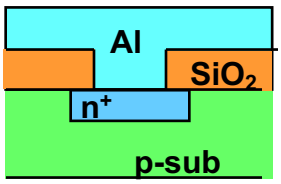

(same rule for Metal-poly)

**Min. contact hole = 2 λ x 2 λ**




**Min contact hole to diffusion layer distance = λ**

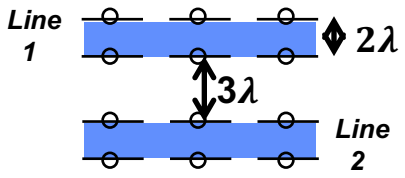


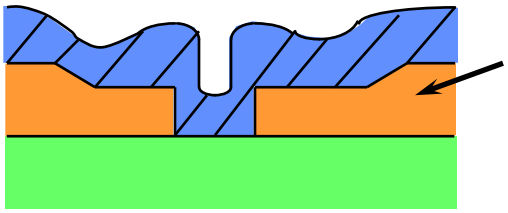



## Metal Lines

**Min width = 2λ**

**Min. metal-metal spacing = 3λ**



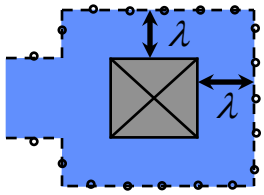



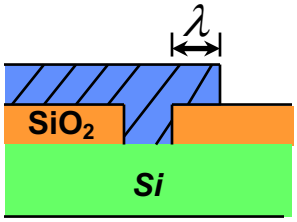

3 λ spacing to ensure no shorting between the 2 lines

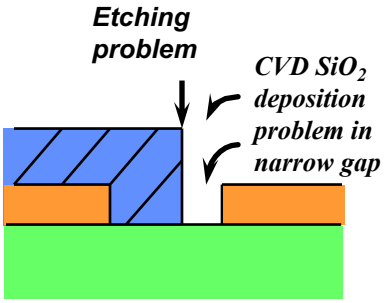


## M1-Contact Overlap

**Min overlap of contact hole = λ**

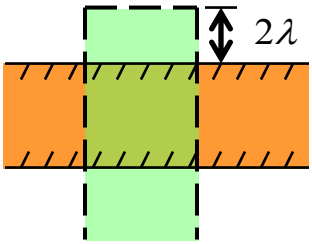


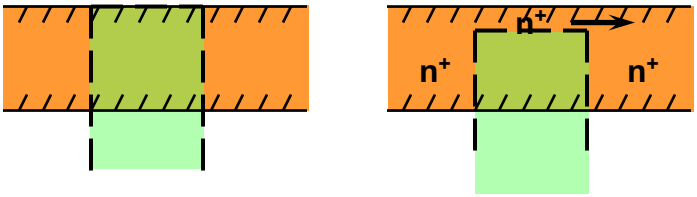



## Poly-Si Gate

**Min gate-overlap of field oxide = $2\lambda$**




**Avoid n+ channel formation during S/D Implant**

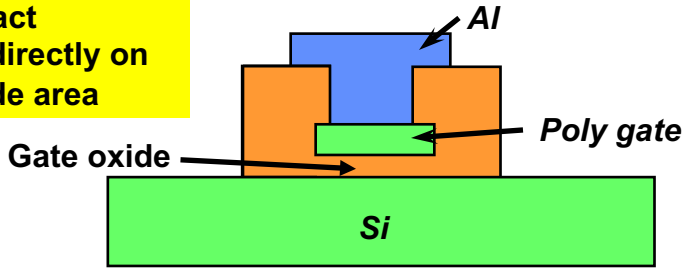


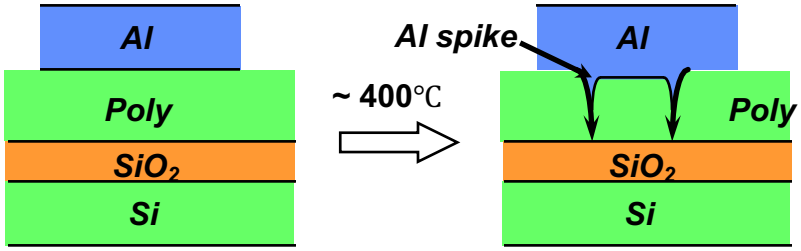

**Ideal** **With overlay error**



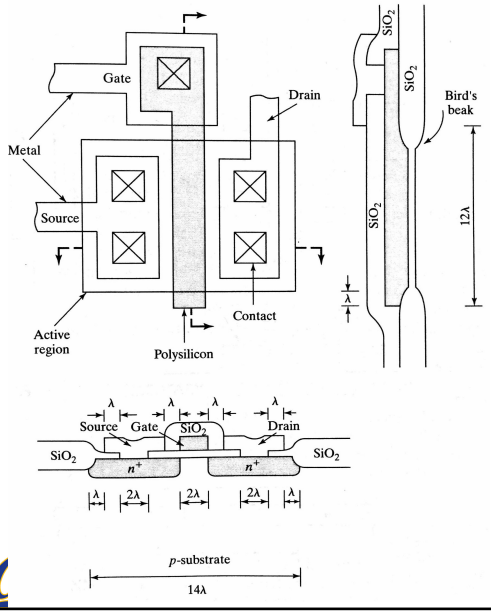
## Gate Contacting

**Comment:**
**Al to poly contact should not be directly on top of gate oxide area**



# Layout of Polysilicon Gate MOSFET




**4 mask process:**

1) **Active region (thin oxide) mask**
2) **Polysilicon mask**
   → **Aligned to level 1**
3) **Contact window mask**
   → **Aligned to level 2**
4) **Metal mask**
   → **Aligned to level 3**

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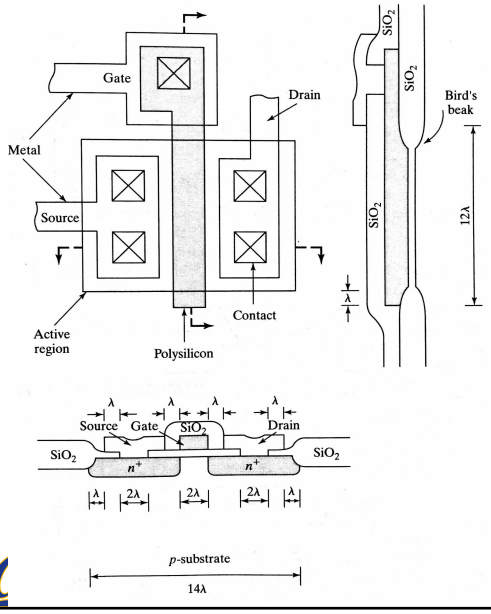
# Layout of Polysilicon Gate MOSFET




- **Example for poly-Si MOSFET with W/L = 5**
  - **L: channel length**
  - **W: channel width**
- **Minimum width in X direction = 14 $\lambda$**
- **Minimum width in Y direction = 12 $\lambda$ (not counting the Al-poly contact)**
- **Transistor area =**
  $$14\lambda \times 12\lambda = 168\ \lambda^2$$
- **Active channel area = 20 $\lambda^2$ (12% of transistor area)**

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