ECE-424 Intro to VLSI

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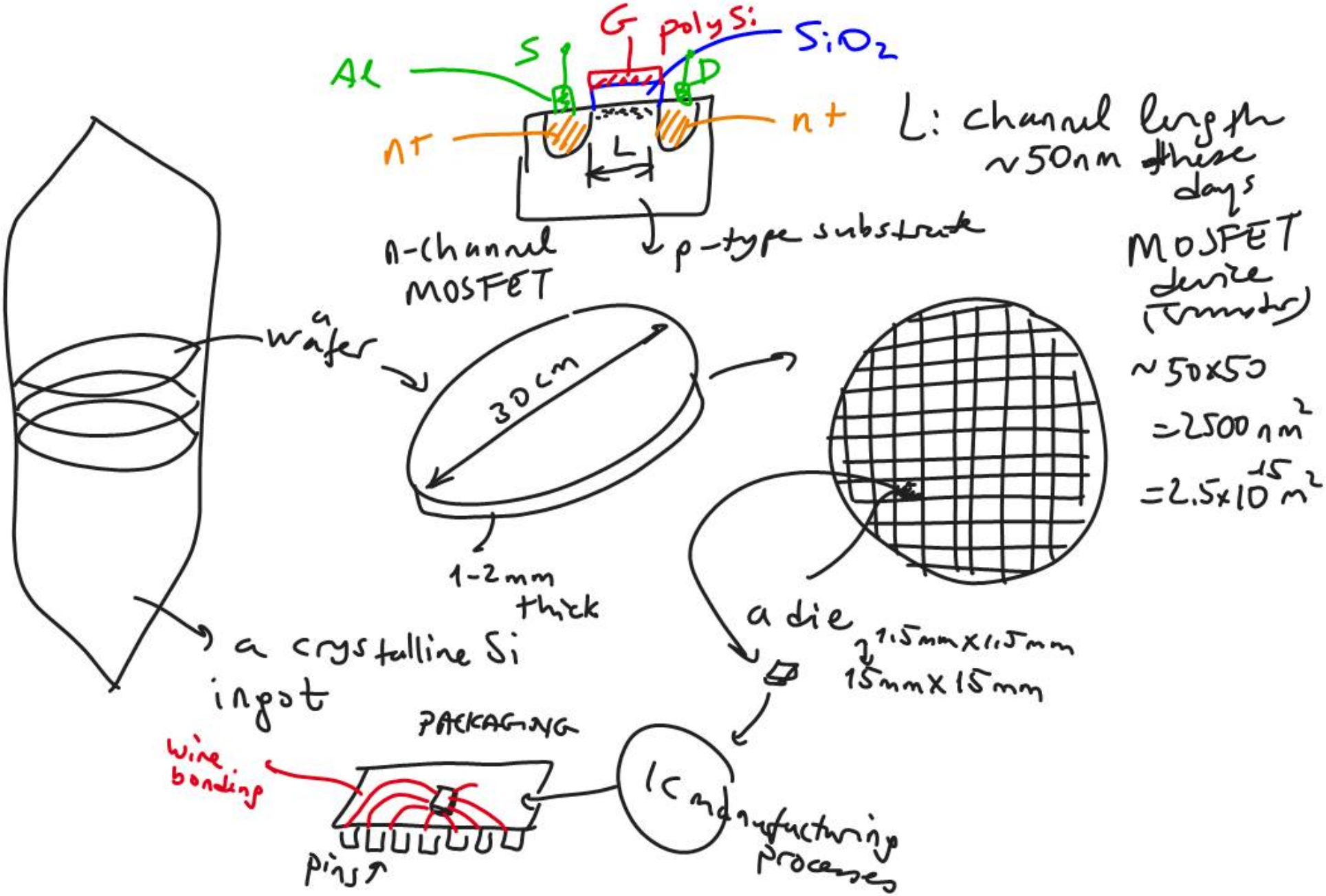

G
poly Si
SiO_2
Al
S
D
n+
n+
L
n-channel MOSFET
p-type substrate
L: channel length
~50nm these days
MOSFET device (transistor)
~50x50
$=2500\,nm^2$
$=2.5\times10^{-15}\,m^2$
a wafer
30cm
1-2mm thick
a crystalline Si ingot
a die
1.5mm x 1.5mm
15mm x 15mm
PACKAGING
wire bonding
pins
IC manufacturing processes

Die size = $15\,mm \times 15\,mm = 225\,mm^2 = 2.25 \times 10^{-4}\,m^2$

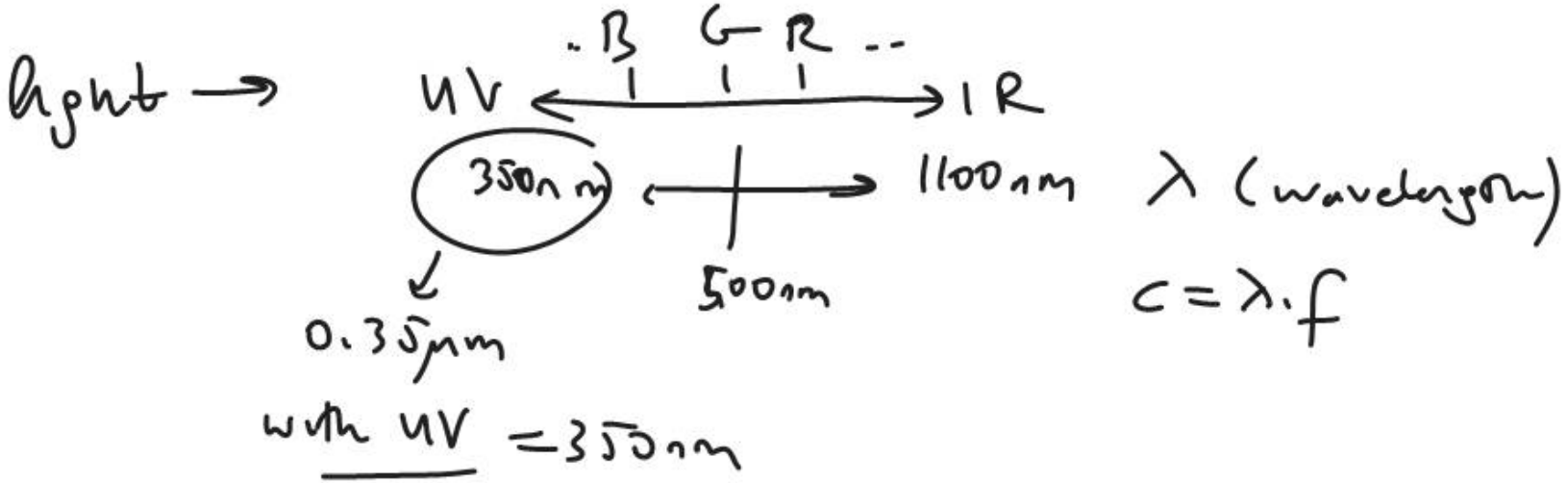
MOSFET's size = $2.5 \times 10^{-15}\,m^2$

$$\frac{2.25 \times 10^{-4}\,m^2}{2.5 \times 10^{-15}\,m^2} \approx 10^{11}$$ transistors theoretically can be inserted into the die.

However, there are many metallization (lines), insulation, etc.

$\sim 2 \times 10^6 - 20 \times 10^6$ transistors on a die

(1) Lithography → to produce masks
to obtain the required patterns on the Si die.



However, the transistor has around 50nm of
channel length.

② Electron beam lithography

doesn't need a mask.

what size (or λ) does e-beam of 10 keV have?

LIGHT

$E = hf$ → frequency

Planck's constant

Light

energy of a photon

Einstein

PARTICLE

$p = \hbar k$ $\quad \hbar = \frac{h}{2\pi}$ $\quad k = \frac{2\pi}{\lambda}$

de Broglie

$p = \frac{h}{2\pi}\frac{2\pi}{\lambda}$

$E = \frac{1}{2}mv^2 = 10 \times 10^3 \text{ eV}$

v is calculated from here

$\lambda = \frac{h}{p}$

$\lambda \sim 10\text{Å}$ $\quad p = mv$ $\quad \Rightarrow E \uparrow$ $\quad \lambda \downarrow$ $\sim 0.1\text{Å}$

3. X-ray