Special Topics on Basic EECS I Design Technology Co-Optimization

Lecture 11

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L11

How to load a CGNS file

- Assume that you have `inverter_fin.cgns`.
  - As the name suggests, it contains the structure after fin formation.
  - Now, you want to draw dummy gates and save the structure with a name of `inverter_dummygate.cgns`.
  - This is the way to load that CGNS file:

```
craft (name="craft",lx=162,ly=288,lz=400,region="DeepSubstrate",thickness=1,cgns="inverter_dummygate.cgns") {
   load (cgns="inverter_fin.cgns")
```

File to be loaded

Match them File to be loaded

Filename at the end of dummy gate formation

One important change

- Declare a region, before you use it.
  - When you want to grow a region,

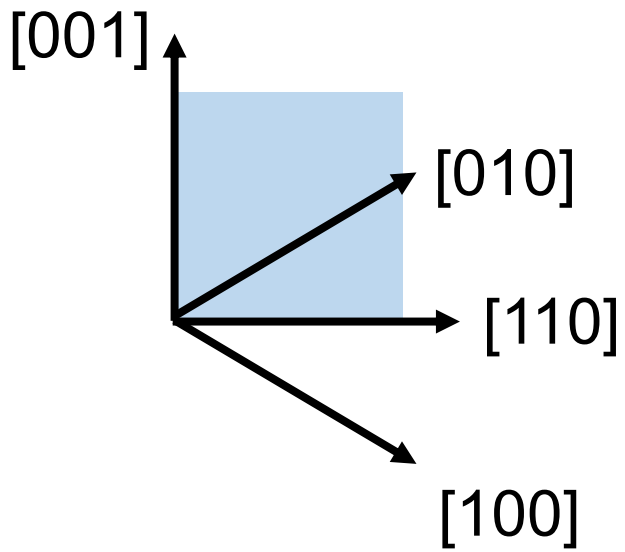
```
region (name="SiGe")
```

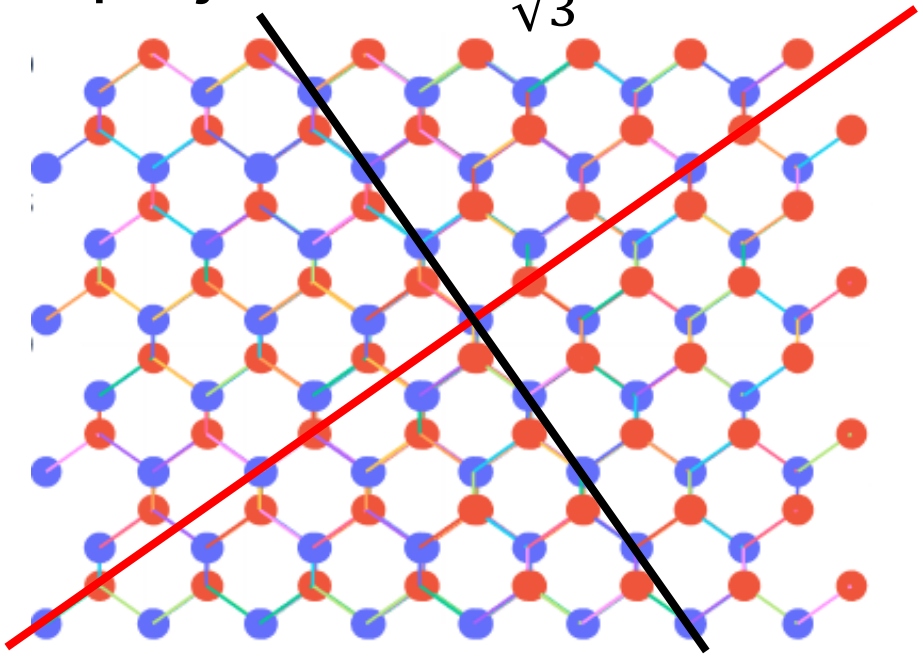
  - If it is not called, your `model` statement cannot recognize it.

```
model (name="model_sd_SiGe") {
    select (region="Silicon")
    select (region="SiGe")
}
```

(001) wafer, [110] channel direction

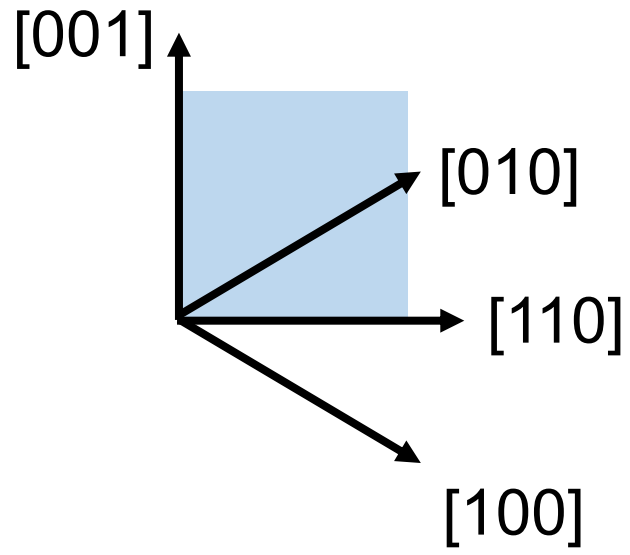
- Silicon crystal structure
  - [111]-directional unit vector: $\frac{1}{\sqrt{3}}\mathbf{a}_x + \frac{1}{\sqrt{3}}\mathbf{a}_y + \frac{1}{\sqrt{3}}\mathbf{a}_z$
  - [110]-directional unit vector: $\frac{1}{\sqrt{2}}\mathbf{a}_x + \frac{1}{\sqrt{2}}\mathbf{a}_y$ ➔ Its projection is $\frac{\sqrt{2}}{\sqrt{3}}$.
  - [001]-directional unit vector: $\mathbf{a}_z$ ➔ Its projection is $\frac{1}{\sqrt{3}}$.
  - Angle: 35.3°
    (Or, 54.7°)

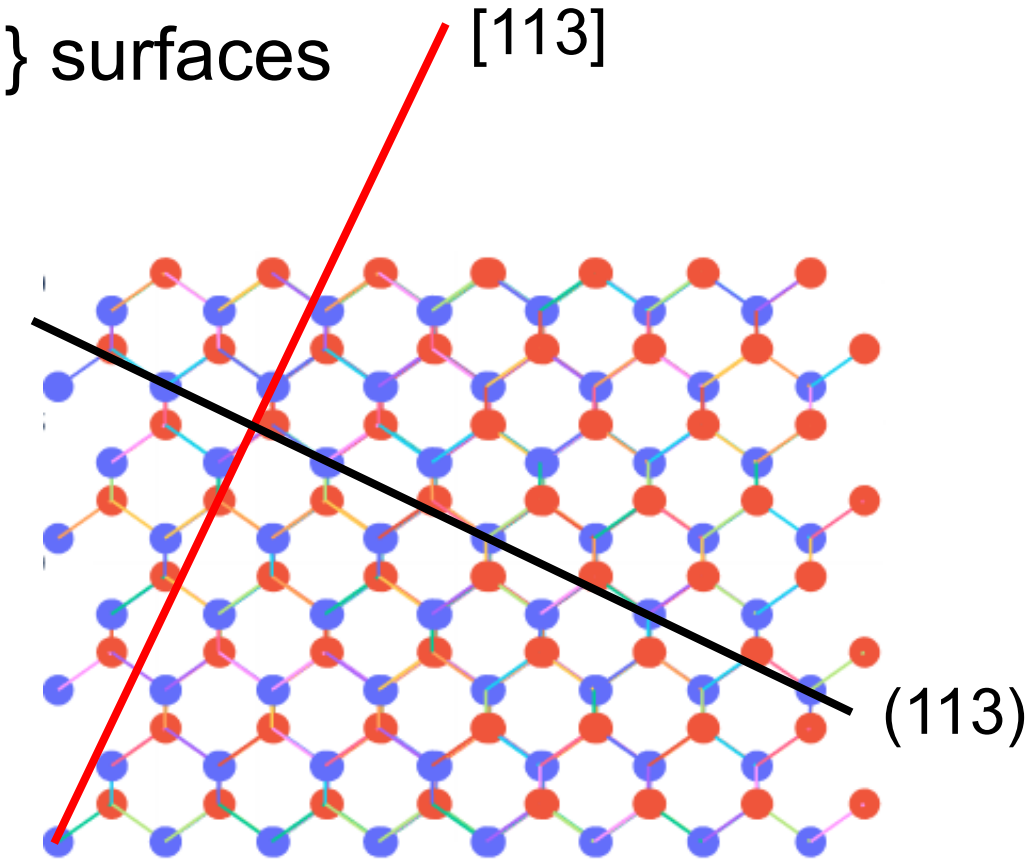




(113) surface

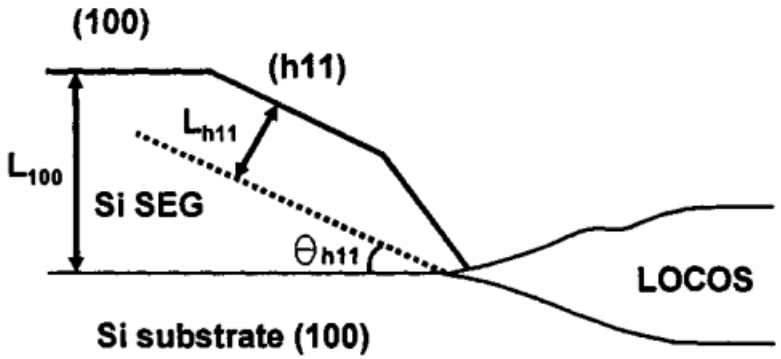
- {311} surfaces are usually found at the initial phase.
  - Angle: 64.7° (Or, 25.3°)
  - Later, dominated by {111} surfaces

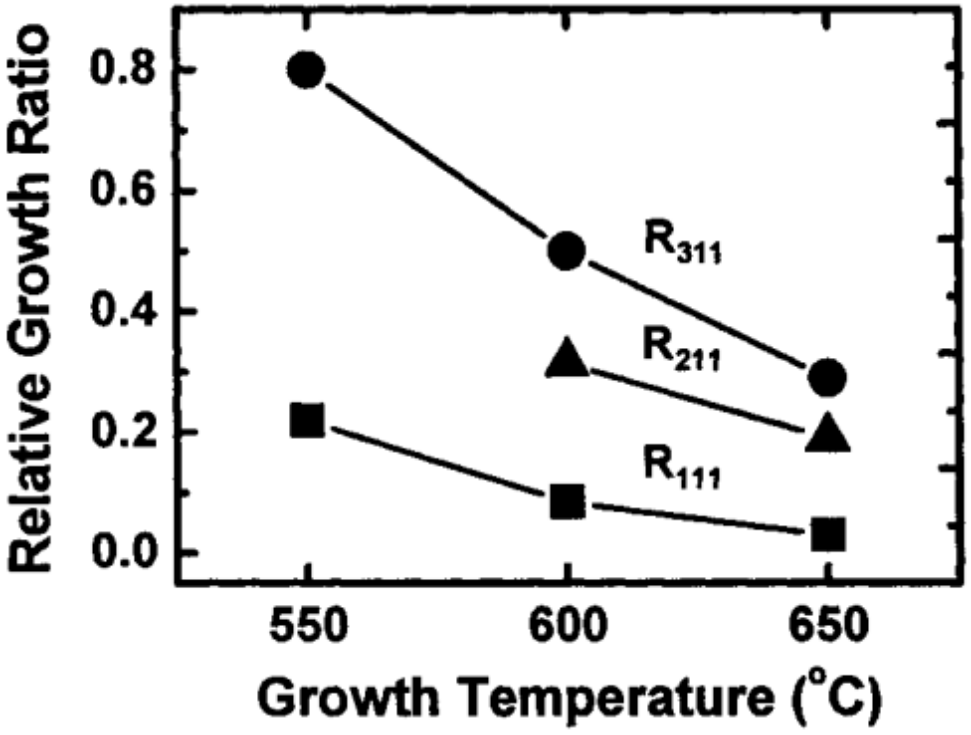




Relative growth ratio

- It is found that the {111} surface growth is the slowest.
  - Anisotropic growth rate

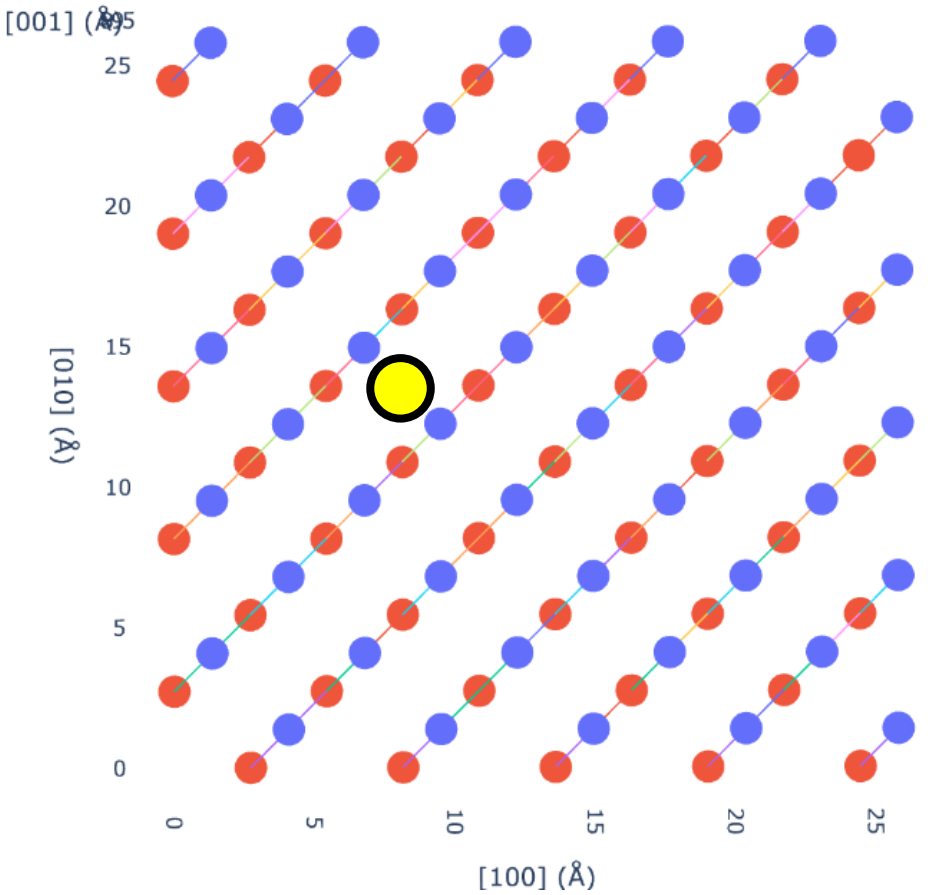




Relative growth ratio of (h11) facets with growth temperature (S.-H. Lim et al., SNU)

(001) wafer surface

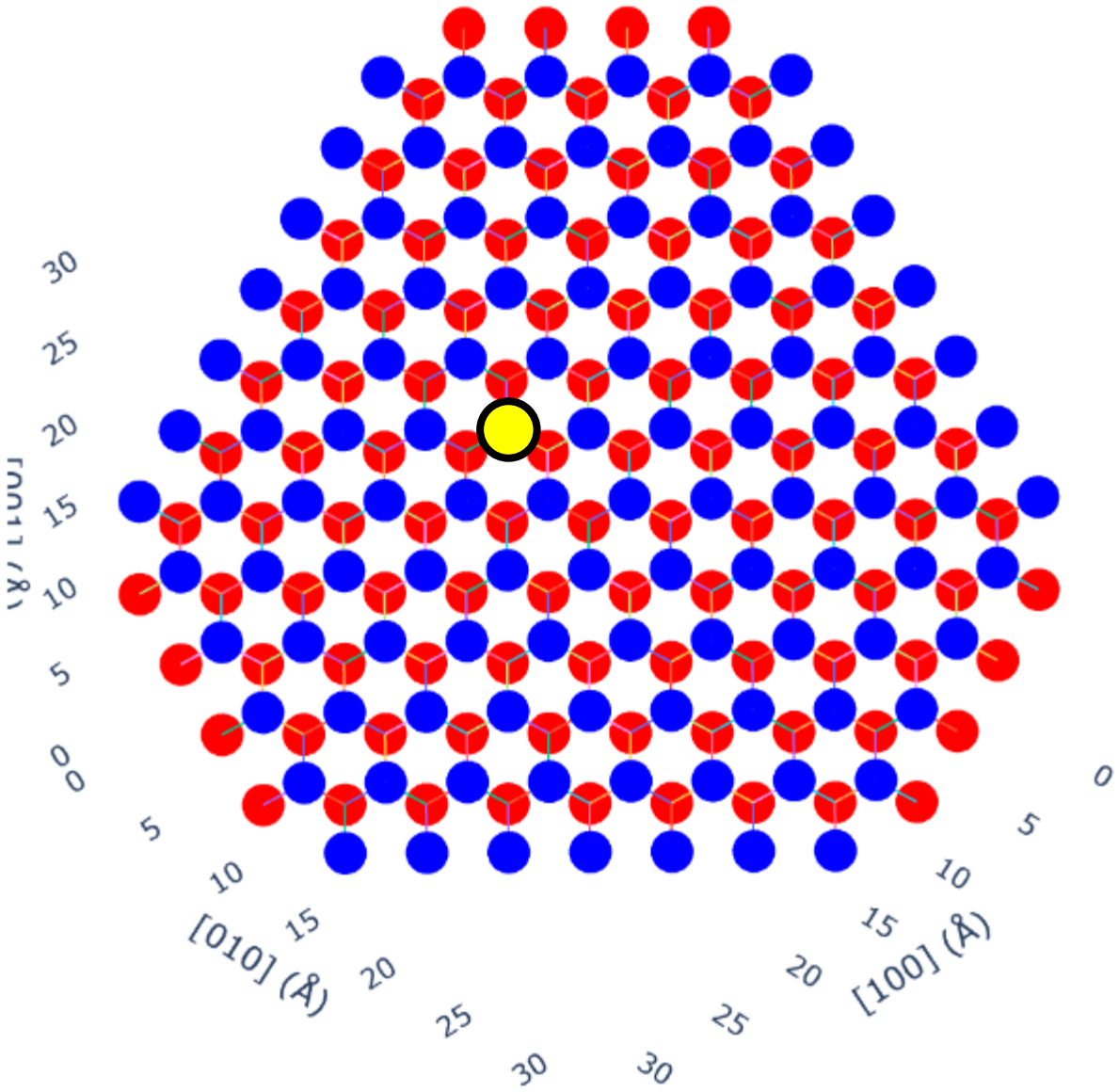
- The top layer (blue) and the second layer (red)
  - Add one additional atom. (yellow)
  - There are two NN atoms.
  - There are four second NN atoms.



(111) wafer surface

- The top layer (blue) and the second layer (red)
  - Add one additional atom. (yellow)
  - There is only one NN atom.
  - There are three second NN atoms.

  (In reality, the actual growth seems to be more complicated…)



Homework#11

- Due: 08:00 on Oct. 20
- Submit a report through the GIST LMS system.
  - By using the load capability, follow L10 lecture material, again. (Whenever you need a `model` statement, first declare a `region`.)

Thank you!