Computational Microelectronics
Lecture 9 Diffusion

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Diffusion – Electric Field

Two dopants

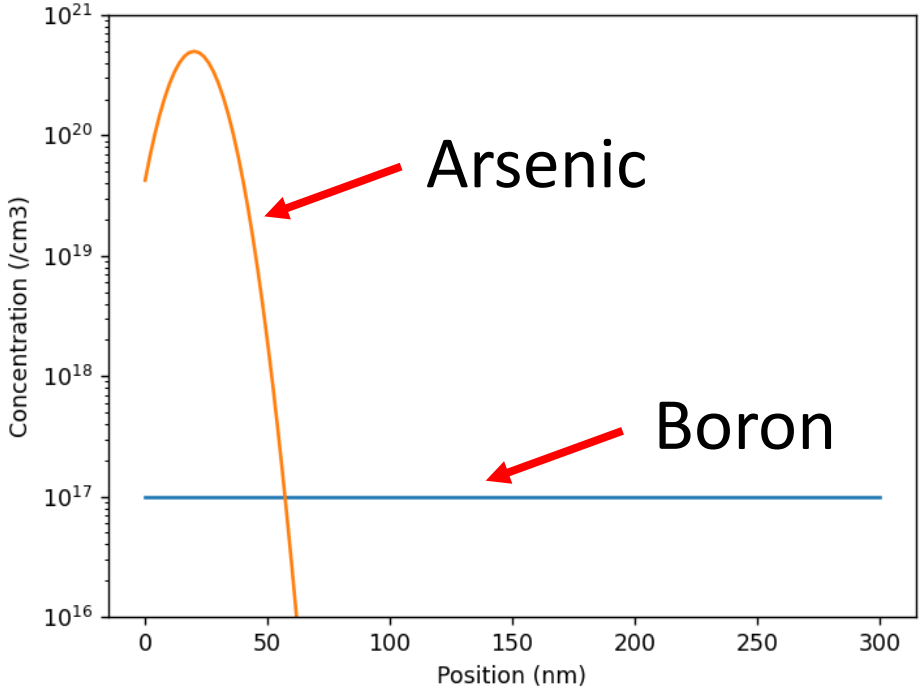
- Consider B and As.
  - Now, the solution vector is $[C_B(x_0)C_{As}(x_0)C_B(x_1)C_{As}(x_1) \ldots C_B(x_{N-1})C_{As}(x_{N-1})]^T$.
  - In the case of boron,

$$F_{C,i+0.5} = -\frac{D}{\Delta x}\frac{1}{\sqrt{p(x_{i+1},t_k)p(x_i,t_k)}} \times [C(x_{i+1},t_k)p(x_{i+1},t_k) - C(x_i,t_k)p(x_i,t_k)]$$

  - Due to n and p, which depend on $C_{As} - C_B$, they are coupled.

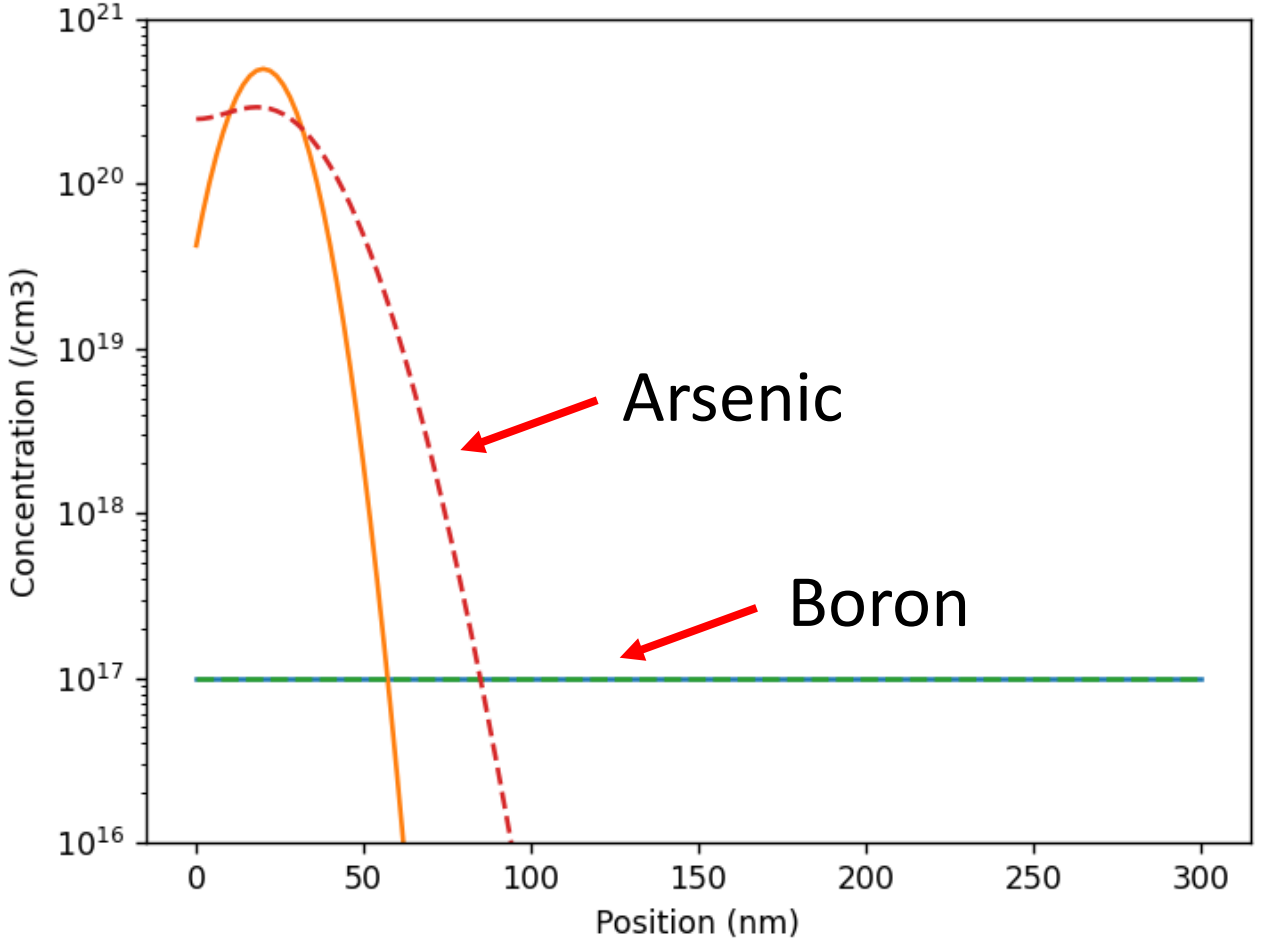
Example

- Consider the following initial profiles and conditions.
  - B: Uniform distribution with a density of 10^{17} cm^{-3}. Diffusivity of 1.40 X 10^{-14} cm^2 sec^{-1}
  - As: Gaussian profile. Peak at 20 nm. Peak density is 5.0 X 10^{21} cm^{-3}. Standard deviation is 9 nm. Diffusivity of 1.47 X 10^{-15} cm^2 sec^{-1}



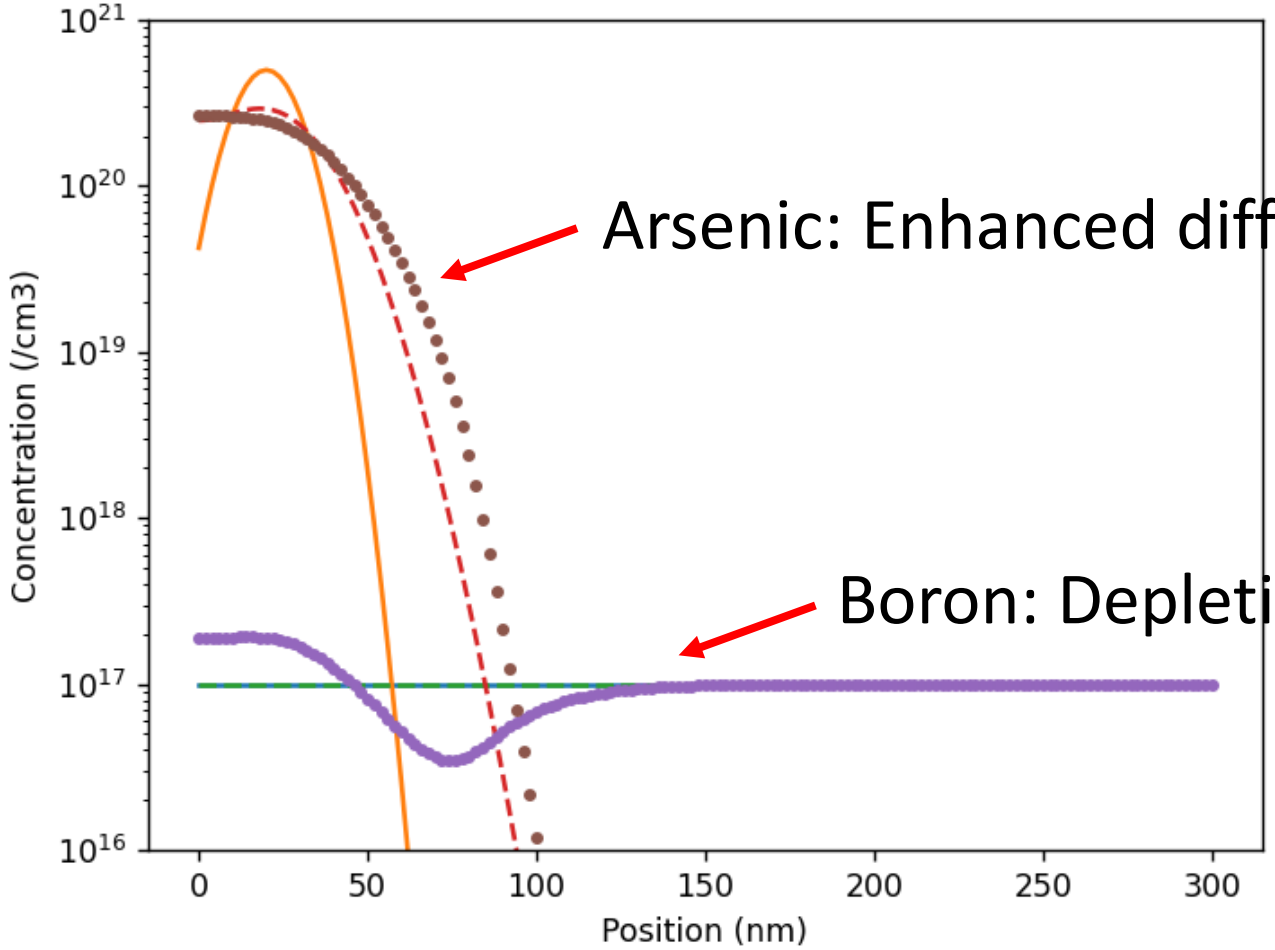
After 10 minutes without electric field effect

- Without the electric field effect,
  - Boron is still uniformly distributed.



After 10 minutes with electric field effect

- With the electric field effect,
  - Boron is pulled into the N+ region.



Arsenic: Enhanced diffusion

Boron: Depletion near junction

HW#9

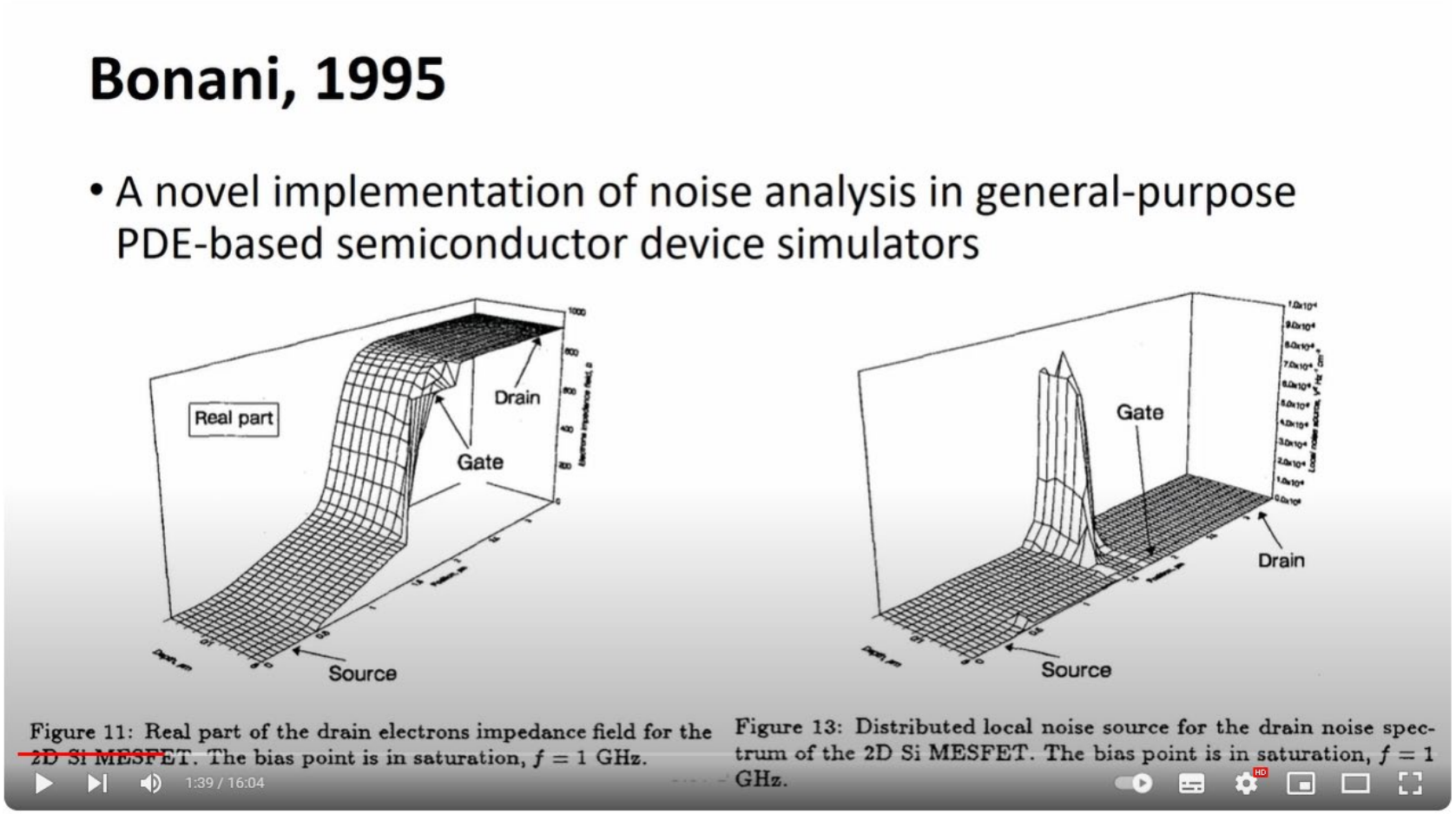
- Due: AM08:00, October 4
- Problem#1
  - Reproduce the last graph. (You may use an approximate Jacobian matrix.)
- Problem#2
  - Predict the dopant profiles after 30 minutes.

Q&A

- Any question?

Lecture 10 is uploaded in my YouTube channel.

- Watch the video. (It is very short, just 16-minutes long.)



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HW#9

- Problem#3
  - Leave a comment on the YouTube lecture video for Lecture 10. (Your comment will be also used to check the attendance.)
- Problem#4
  - I have shown 11 IEDM papers. Select one paper and submit a report on the selected paper. (Of course, you don't have to write a perfect report. Just try to undertstand the main idea.)
  - In a case where you have your own favorite IEDM paper, it is okay to review it.

Thank you!