

Fundamentals of Semiconductors: Physics and Materials Properties

Course Number: ECE 692/599

Credits: 3 hours

Times: 11:10 am - 12:25 pm Tue & Thu

Location: Min Kao Engineering Bldg., Rm 639

Instructor: Gong Gu

An **interdisciplinary** course that welcomes graduate students from departments of EECS, Physics, MSE, Chemistry, etc. Although not considered a prerequisite, it helps to prepare students for ECE 635 Advanced Semiconductor Devices. It serves multiple purposes:

- To prepare **EE students** in electronic materials and devices related research areas with adequate background knowledge in semiconductor physics and processing;
- To bridge the gap between frontier research in condensed matter physics and real-world applications in the semiconductor industry for **Physics and Chemistry students**; and
- To relate advanced materials research, including materials preparation and characterization techniques, to micro- and nanoelectronics for **MSE students**.

List of topics

1. Introduction/survey: review and survey widely used concepts, **raising questions** that lead you to advanced inquiries
2. Semiconductor crystal structures and electronic band structures: a quick quantum mechanics primer/review, periodic crystal structures and energy bands, unified band (physics) and bond (chemistry) pictures
3. Defects, doping, carrier statistics
4. Lattice vibrations (phonons), thermal & mechanical properties
5. Electrical transport: semiclassical model, mobility, scattering mechanisms; ballistic/quantum transport
6. Optical properties
7. Surfaces and interfaces: The interface is the device!
8. Semiconductor material characterizations
9. Semiconductor material growth and processing
10. Selected advance topics (TBD by student research areas and interests: e.g. wide-band gap semiconductors for power electronics, defect engineering for memristors, first-principles methods for computational materials science or condensed matter physics, etc.)

Reference books (*not* textbooks)

On semiconductor physics

Peter Y. Yu & Manuel Cardona, *Fundamentals of Semiconductors: Physics and Materials Properties*, 4th Edition. [Available as e-book and paper book at UT Library.](#)

Marius Grundmann, *The Physics of Semiconductors An Introduction: Including Nanophysics and Applications*, Third Edition.

On broader solid-state physics

Marvin L. Cohen & Steven G. Louie, *Fundamentals of Condensed Matter Physics*.

On quantum mechanics

The Feynman Lectures on Physics Vol. III. Available online:

https://www.feynmanlectures.caltech.edu/III_toc.html

On semiconductor processing

Plummer, Deal, and Griffin, *Silicon VLSI Technology: Fundamentals, Practice and Modeling*, Dorling Kindersley, 2009.

Grading

Your mark will be the weighted sum of scores earned on graded homework assignments (20%), class participation (20%), a mini project (20%), and a take-home comprehensive final exam (40%). A letter grade will be assigned according to your mark relative to the rest of the class.

Course Website

Available soon: <https://web.eecs.utk.edu/~ggul1/files/GradHome.html>