Micro and nanotechnology

KEXNTBAMNE (English, MSc)
Starting at 2017/2018
State exam's questions

1. Show the characteristic material formats of solid state, and the Miller – Bravais system used to describe the crystalline materials! Describe the crystal structure of the elementary semiconductors (Si, Ge)! Shortly describe the metallic, ionic, covalent, and molecule crystals! Summarize the different density definitions used in the crystallography!

2. Describe the experimental evidences of the material – wave duality of the matter! Show the band structure of the crystalline material! Describe the intrinsic and the extrinsic semiconductors! Give the continuity equation and explain its different components!

3. Explain the operation principle of the bipolar transistor, show the potential diagram and the current – voltage characteristics of the p – n junction (diode)! How the bipolar planar transistor, the resistor, and the capacitor produced by a bipolar IC technology?

4. Explain the operation principle of the MOS FET and the CMOS inverter! Show the basic steps of the CMOS technology using the CMOS inverter as an example!

5. Describe the photoelectric devices, show the differences between photo-diode, LED, and laser diode!

6. Describe the raw material production and the methods of the crystal growth and of the impurity removal! (Czochralski's and Bridgman's Method, Float-zone Process)

7. Describe the different layer growth techniques applied in the semiconductor device technologies (Liquid Phase Epitaxy, Vapor Phase Epitaxy, Molecular Beam Epitaxy)!

8. Describe the different layer deposition techniques of the the semiconductor device technologies (evaporation, sputtering, CVD, and the silicon-dioxide growth by thermal oxidation)!

9. Describe the different doping processes of the semiconductor device technologies (thermal diffusion, ion-implantation)!

10. What are the pattern formation processes? Describe the photo-, the electron-lithography, and the different etching processes!

11. Describe the different planarization methods (P-glass, CMP – chemical mechanical planarization). What is its role in the IC and MEMS technology?

12. Introduce the Micro – Electro – Mechanical – Systems, describe their basic characters and work principles! Show one MEMS example!

13. Describe the bulk and the surface micromachining! Show the purpose of the sacrificial layer! Compare the MEMScap PolyMUMPS and the Draper dissolved wafer process!

14. What is the nanotechnology? Describe the basic approaches of nanomaterial and nanostructure production, give an example for each! Why the structure's behavior is changing due to the size reduction?

15. Compare the optical and the electron microscopy! Describe the TEM and the SEM devices! What is their resolution limits?

16. Describe the scanning tunneling microscope! Show its working principle (the quantum-mechanical tunneling). How could it be used as a measuring or as a surface modification tool (STM Lithography)?

17. Describe the atomic force microscope (AFM)! How could its resolution be improved using the nanotechnology (CNT)?

18. Describe the application of the electron beam lithography in the nanotechnology! Show structure of the EB lithography system, and the different pattern writing methods! How is the STM applied as a lithographic tool?

19. Describe the electron beam induced deposition (EBID) and the focused ion beam deposition techniques (FIBD)! Show their deposition process and the device arrangement! Describe the Atomic Layer Deposition! Show the deposition sequence, give an example of its application!

20. Describe the Nano – Electro – Mechanical – System! What is the effect of the sensors downscaling? How is the nanomaterial applied in the bio-sensors and in the solar energy harvesting?

21. Show the carbon based nanomaterials (CNT, graphen, C60)! Describe their structures, relation of the structure and the electrical character! Show the production methods of the CNT! Show the mechanical and thermal parameters of the CNTs!

22. Show the electrical behavior of the CNT! Describe the structure of the CNT transistor and the CNT logic inverter! Show some further applications of the CNTs!