

## **Master program "Materials of Photonics"**

### **Study track: Advanced Materials & Technologies of Photonics**

#### **Entrance Examination Questions**

1. Definition of nanomaterials. Examples of nanomaterials. Difference between traditional materials and nanomaterials.
2. Difference between structural and functional materials.
3. Maxwell's equation and their physical meaning.
4. Propagation of electromagnetic waves in an isotropic dielectric.
5. Propagation and absorption of electromagnetic waves in a conductive medium.
6. Electronic structure of dielectrics. The most important dielectric characteristics: electric susceptibility, permittivity, dielectric losses, electrical breakdown.
7. Energy zones and Brillouin zones. One-dimensional and two-dimensional cases.
8. Elastic vibrations of crystal lattice. Acoustic and optical phonons.
9. The flat and mirror boundary of the dielectric. The law of conservation of the tangent component of the wave vector of light at the mirror boundary. The laws of reflection and refraction, total internal reflection (TIR). Transverse electric (TE) and transverse magnetic (TM) waves. The Brewster phenomena in TM polarization.
10. Frequency dependence of refractive index. Transparent (transition) and fundamental absorption regions, their mutual arrangement. Normal and anomalous dispersion.
11. Electronic band structure of semiconductors in comparison with metals and dielectrics. Band gap, valence band, conduction band.
12. Types of conductivity in semiconductors. Electron and hole conductivity. Intrinsic and impurity conductivity.
13. Carrier generation and recombination in semiconductors.
14. Donor and acceptor impurities in germanium (Ge); n-p, p-n, p-n-p junctions.
15. The effect of temperature on intrinsic / impurity / total conductivity.
16. Hall Effect. Measurement of the concentration and mobility of charge carriers.

17. Thermoelectric phenomena (effects of Thomson, Peltier, Seebeck). Physical principle of thermocouples.
18. Defects in crystals. Classification and characteristics.
19. Dislocation. Types of dislocations. Sources of dislocations. Dislocations and physico-mechanical properties of a crystal.
20. Point defects and their effect on the physico-mechanical properties of the crystal.
21. Main classes of optical materials and features of their application in photonics.
22. Main optical glasses groups and their optical properties and chemical composition. The physico-chemical properties of each glasses group.
23. Crystallography and the concepts of crystal lattices symmetry.
24. Crystal systems (lattice systems) and optical properties of crystals.
25. Physical properties of the main crystalline media that used in modern optics: crystals of pass-through optics of UV, visible and IR wavelength ranges; crystals of polarization optics; crystals for nonlinear optical transformations; crystals for laser applications.
26. The effect of the type of crystal system on the optical and other physical properties of optical crystals.
27. Elementary processes of crystal growth.
28. The influence of various external factors on the crystallization process.
29. Phase transitions in crystalline solids.
30. Methods of crystal growth. Technology features for producing optical and semiconductor crystals.