Joint syllabus

«Experimental physics of microwaves and nanomaterials»

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Degree program: 010900 «Applied Physics and Mathematics»
Specialization: 010988 «Physics of microwaves and nanomaterials»
Chair of Laser Systems & Structured Matter
1st academic year of the Master’s degree
2nd semester

Head of chair, academician of RAS
I.A. Shcherbakov

Lecture 1. Introduction to the course– 2 hours
(Experimental methods in solid state physics and physics of nanomaterials. Structural analysis, spectroscopic methods and magnetometry)

(X-ray diffraction studding of crystal structure of nanomaterials. Neutron and electron diffraction techniques. Microscopy: optical, electron, scanning probe microscopy. Imaging methods of nanostructures and heterostructures.)

Lecture 4. Spectroscopy - 2 hours.
(Electromagnetic spectrum. Experimental methods of optical spectroscopy. THz gap.)

Lecture 5. Optical spectroscopy of solids- 2 hours.
(Basic principles of optical spectroscopy of solids. Time-domain and frequency-domain spectroscopy. Interferometric spectroscopy.)

(Definition of the impedance of a material. Low-frequency measurement methods. Resonators, waveguides, coaxial lines, striplines and circuits. Corbino spectroscopy.)

Lecture 7. Infrared spectroscopy of solids and nanostructures. - 2 hours.
(Fourier transform. Thermal sources of electromagnetic radiation. Phonon spectra. Kramers-Kronig relations.)

(Elastic scattering of electromagnetic waves. Raman spectroscopy of solids and nanostructures. Polarization of electromagnetic radiation. Ellipsometry principles. Experimental technique of far infrared ellipsometry.)
Lecture 9-11. Methods and techniques of terahertz spectroscopy. - 6 hours.
(Terahertz gap. Sources of microwave radiation: solid state devices, lasers, vacuum tubes, heat radiation sources. Frequency multipliers for terahertz region. Detectors of terahertz radiation)

(Basic principles of terahertz time-domain spectroscopy. Sources and detectors used in TDS: photoconductive antennas and detectors, optical rectification, photo-Dember effect, Pockels effect.)

(Basic principles of frequency-domain terahertz spectroscopy. BWOs. Quasi-optical configuration. Mach-Zehnder interferometer. Near field Terahertz spectroscopy.)

Lecture 14. Terahertz waves in medicine, biology and defense. - 2 hours.
(Using of the terahertz radiation in medicine, biology and defense. Terahertz imaging and its limits.)

Lecture 15. Photoemission spectroscopy. - 2 hours.
(Basic principles and instrumentation of angle resolved photo emission spectroscopy (ARPES).)

Lecture 16. Magnetometry. - 2 hours.
(Electron paramagnetic (EPR), electron spin (ESR) resonance spectroscopy, nuclear magnetic resonance (NMR) spectroscopy. Tomography. Muon spin spectroscopy. Mössbauer effect.)

References

Basic references

Additional references