Photoacoustic nanoscopy

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Photoacoustic methods of non-destructive testing and evaluation (NDTE) of structures and materials are of great interest due to their contactless nature. The techniques of acoustic waves generation and detection by lasers are the most widespread. Currently laser ultrasonics allows better than picosecond temporal resolution but, similar to photoacoustic microscopy [1-4], is restricted to sub-micrometric spatial resolution in visible range because of the light diffraction limit. Following continuous increase of the nanostructures and nanocomposites application in modern science and technology the development of photoacoustic methods of NDTE with nanometric spatial resolution becomes more and more required.

We demonstrate experimentally that spatial resolution of photoacoustic imaging could be reduced from ”micro” to ”nano” by applying near-field optics technique. Localization of optoacoustic conversion process in nanoscale volume of material was achieved by focusing pump laser radiation on the apex of the atomic force microscope (AFM) tip placed in the vicinity of the material surface. The detection of laser-generated acoustic waves, emitted and propagating in the sample, was achieved by the beam-deflection technique. The amplitude of detected acoustic signal depends on a number of material parameters in the region of photoacoustic conversion such as light absorption/reflection coefficients, thermal expansion coefficient, electron-hole-phonon deformation potential in semiconductors, elastic moduli, etc. The realized combination of photoacoustics with AFM constitutes the basis for the transfer of photoacoustic spectroscopy [1], microscopy [2], and imaging [3] to nanoscale. The experiments conducted on nanostructured samples provide examples of the photoacoustic nanoscopy and nanoscale photoacoustic imaging.

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