Experimentally acquired basic relaxation stages in ultrashort-pulse laser excited diamond

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Basic relaxation stages–electron-hole plasma photogeneration, ambipolar diffusion, Auger recombination and electron-lattice thermalization, accompanied by different stress states and final structural transformations of optically-active nitrogen-vacancy clusters–were acquired upon ultrashort-pulse (femto-picosecond) laser photoexcitation in the focal volume inside a bulk diamond by different experimental methods, such as transient and CW photoluminescence, spontaneous Raman scattering, electron microscopy. Ultrahigh ambipolar diffusion coefficient (up to 1 m2/s), electron-lattice thermalization time of 2 ps, multi-GPa isotropic plasma-induced, anisotropic hot-phonon mediated and final thermal stresses were measured, resulting in locally transformed nitrogen-vacancy clusters, exhibiting strongly enhanced diamond photoluminescence. The acquired electronic, electron-lattice and lattice parameters make a good point for plasma concentration-independent two-temperature modeling coupled with thermoelasticity. Potential atomistic transformation mechanisms and emerging implications of the direct laser inscription technology are considered. This research is supported by Russian Science Fund (project No. 21-79-30063).