NATURE AND KINETICS OF NONSTATIONARY LIGHT ABSORPTION IN C_{60} FILMS INDUCED BY FEMTOSECOND LASER PULSES

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S u m m a r y

Using the "pump–probe" technique, the structure and the temporal evolution of the light absorption in C_{60} films induced by femtosecond laser pulses in the spectral range of 2.04–2.37 eV and the pulse time interval of 0–882 ps have been studied. C_{60} films 200 nm in thickness were obtained by thermal evaporation onto quartz substrates in a vacuum of 0.65 mPa and at room temperature.

In the probe range of 2.04–2.37 eV, the shape of the absorption spectrum induced by femtosecond laser pulses in a C_{60} film consists of bands at 2.097, 2.164, 2.209, 2.262, 2.299, and 2.331 eV. The bands at 2.097, 2.209, and 2.262 eV are induced by electron transitions between the energy bands created by zero vibronic levels of the S_0 state and nonzero vibronic levels of S_1 state of C_{60} molecules.

For the first time, it has been shown that the "hot" bands at 2.164, 2.299, and 2.331 eV result from the electron transitions either between the energy bands created by three nonzero vibronic levels of S_0 state, on the one hand, and the zero vibronic level of S_2 state, on the other hand, or between the energy bands created by three nonzero vibronic levels of S_1 state, on the one hand, and the zero vibronic level of S_4 state, on the other hand, of C_{60} molecules.

The decreasing temporal kinetics of the optical density D under the induced absorption in C_{60} films was approximated by a sum of three exponential terms in the pulse time interval of 0–882 ps. For probe photons with the energy $E = 2.217$ eV, the following values of relaxation times were obtained: $\tau_{r1} = (1.04 \pm 0.13)$ ps, $\tau_{r2} = (5.81 \pm 0.94)$ ps, and $\tau_{r3} = (108.0 \pm 9.3)$ ps. The approximation of those kinetics by the Kohlrausch function (the "stretched" exponent) allowed us to evaluate the effective relaxation time τ_r as 6.0 ps, which is close to the τ_{r2}-value. The electron subsystem of C_{60} films needs the time interval $\Delta t > 882$ ps to relax into the equilibrium state.

The quantities τ_{r1} and τ_{r2} are found to depend significantly on the approximation time interval and the method used for averaging the kinetics $\Delta D_n(t)$. For τ_{r3}, this dependence is much weaker.