Threshold effect under High-Power Laser Limiting for Flat Top Pulse Shape

Savelyev M.S.1,2,3, Vasilevsky P.N.1,3, Kuksin A.V.1,3, Gerasimenko A.Yu.1,2,3

1National Research University of Electronic Technology, MIET, Zelenograd, Moscow, Russia  
2I.M. Sechenov First Moscow State Medical University, Sechenov University, Moscow, Russia  
3Institute of Nanotechnology of Microelectronics, Russian Academy of Sciences, INME RAS, Moscow, Russia

savelyev@bms.zone

An analytical solution is obtained for the nonlinear radiation transport equation for the threshold dependence of the absorption coefficient on the intensity of a laser beam that has a flat-top intensity shape. The advantage of this formula is the ability to perform the necessary calculations of the nonlinear absorption coefficient and threshold intensity. The use of a threshold model makes it possible to describe more accurately the experimentally obtained Z-scan curve with an open aperture. Approbation of the threshold model for the case of a rectangular pulse was carried out with samples of liquid dispersed media of carbon nanotubes with phosphazene-substituted phthalocyanines. It made it possible to estimate the influence on the values of the transmitted energy density and the attenuation coefficient of such characteristics as the thickness of the sample and the size of the laser spot for the same incident total energy of the laser beam. Such calculations are useful for choosing the optimal, confocal optical design for the use of a material with non-linear optical effects. A laser radiation limiter of this design is a passive protection device, the turn-on speed of which, in accordance with the results obtained, is about 16 ns, which is faster than any active laser radiation protection device. This device limits the transmitted output intensity to less than the destruction threshold of the photosensitive element. The developed dispersions are promising for the creation of nonlinear optical materials with a high attenuation coefficient, low threshold intensity, and a high damage threshold.