2. Trokhimchuck P. Some Peculiarities of Creation the Laser-Induced Thin Films. International Journal of Scientific Research and Engineering Trends. Vol. 11, is. 2, 2025. P.1206-1217.

Some problems of modelling the optical-induced Cherenkov radiation

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The main problems of nature the optical-induced Cherenkov radiation are discussed. We show that this problem are connected with problem of shork excitation of heterogeneous polarization the irradiated matter [1-9].

Cherenkov radiation (Vavilov–Cherenkov effect) is electromagnetic radiation emitted when a charged particle (such as an electron) passes through a dielectric medium at a speed greater than the phase velocity (speed of propagation of a wavefront in a medium) of light in that medium [1 – 4, 8, 9]. A classic example of Cherenkov radiation is the characteristic blue glow of an underwater nuclear reactor. Its cause is similar to the cause of a sonic boom, the sharp sound heard when faster-than-sound movement occurs. The phenomenon is named after Soviet physicist Pavel Cherenkov [2, 4].

But Cherenkov radiation may be represented as Nonlinear Optical phenomenon two [8, 9]. Therefore, we must researched this effect in more widely sense as radiational relaxation of shock nonlinear excited heterogeneous polarization. This determination is more widely as traditional. It conclude various ways of excited this polarization, including laser irradiation.

The main problems of nature the optical-induced Cherenkov radiation are discussed. We show that this problem are connected with problem of shork excitation if heterogeneous polarization the irradiated matter. With this point of view the Cherenkov radiation is Nonlinear Optical (NLO) phenomenon [8, 9]. But classical NLO effects are phenomena with homogeneous shock-excited polarization. Two aspects of modeling this phenomenon are observed. First, microscopic, is based on synthesis A. Bohr theory of representation the Cherenkov radiation on the basis the scattering charge particles in media. This theory gives hyperboloid of the shape of the particle's braking track in the medium. Generating cones of Cherenkov radiation are formed by external normals to the A. Bohr hyperboloid [1]. Second, macroscopic is based on I. Golub model of formal analogy Snell law and Cherenkov radiation [3]. Cherenkov speed is determined as speed of shock nonlinear polarization of irradiated matter. Synthesis A. Bohr and I. Golub models allow to determine the product of nonlinear laser-induced refraction index and cpeed of nonlinear polarization [8, 9]. The essential difference between optically induced and classical (obtained by gamma quanta or charged particles) Cherenkov radiation lies in the radiation distribution spectrum. The classical spectrum is more homogeneous, since each particle "has" its own hyperboloid. For the optical case, we have the number of cones, which is related to the mode structure of laser radiation. So for the TEM_{00} fashion we have only one cone [8, 9]. That is why the radiation spectrum will be more heterogeneous, as in the classic case: ultraviolet radiation will be in the central part, and infrared radiation will be at the edges. The observation of laser-induced Cherenkov radiation is connected with problem of diffraction stratification and known as surface continuum radiation [8, 9].

Problems of the observation the Cherenkov radiation and shock processes in matter as Nonlinear (NLO) and Relaxed (RO) Optical processes are connected with acoustic (thermal) and electromagnetic (plasma and Nonlinear optical) nature [8, 9]. These processes may be connected with diffractive stratification of laser beam, including self-focusing, self-trapping, and after this generation of supercontinuum radiation (ordered – Cherenkov radiation, and disorder – plasma radiation) [8, 9].

References

1. Bohr A. Atomic penetration in atomic phenomena. Det KGL Danske Xidenkabernes Selskab Matematisk-Fysiske Meddelelser, Bind XXIV, Nr. 19, 1948. P. 1 – 52. In: N. Bohr. The penetration of atomic particles through matter. Moscow: Inostrannaya literatura, pp. 105–143. (In Russian)
2. Frank I. M. Vavilov-Cherenkov radiation. Theoretical aspects. Moscow: Nauka, 1988. 286 p. (In Russian)
3. Golub I.) Optical characteristics of supercontinuum generation. Optics Letters, vol. 15, 1990. P. 305-307.
4. Jelley, J. V. Čerenkov radiation and its applications. New York: Pergamon, 1958. 304 p.
5. Okada T., Tomita T., Matsuo S., Hashimoto S., Ishida Y., Kiyama S., Takahashi T. Formation of periodic strain layers associated with nanovoids inside a silicon carbide single crystal induced by femtosecond laser irradiation. J. Appl. Phys., vol. 106, 2009. P.054307, 5 p.
6. Okada T., Tomita T., Matsuo S., Hashimoto S., Kashino R., Ito T. Formation of nanovoids in femtosecond laser irradiated single crystal silicon carbide. Material Science Forum, vol. 725, 2012. P. 19 – 22.
7. Trokhimchuck P. P. Relaxed Optics: Modelling and Discussions. Saarbrukken: Lambert Academic Press, 2020. 249 p.
8. Trokhimchuck P. P. Relaxed Optics: Modelling and Discussions 3. New Dehli: Bridght Sky Publisher, 2024. 242 p.
9. Yablonovich E. Optical Dielectric Srength of AlkaliHalide Crystalls Obtained by Laserinduced Breakdown. Appl. Phys. Lett., vol. 19, is. 11, 1971. P. 495-497.