INVESTIGATION OF THE CHANGE IN THE CORRECTION FACTOR TO THE APPARENT VELOCITY OF THE MOVING CONTACT BOUNDARY OF A SAMPLE-WINDOW DURING MODELING OF THE SHOCK COMPRESSION OF A LiF CRYSTAL

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Optical techniques, such as VISAR or PDV, are actively used to study the properties of materials under dynamic loads [1]. For such measurements, transparent materials that withstand high pressures are often used as windows. Optically transparent crystals, such as lithium fluoride, quartz, and plexiglass, are often used as windows. Lithium fluoride remains in a solid state under shock-wave loading up to 160 GPa [2] and maintains its transparency even at higher pressures [3]. To interpret the experimental data, it is necessary to introduce a correction factor that relates the apparent mass velocity, obtained experimentally, to the true mass velocity. Thus, it is necessary to know the optical properties of the crystal accurately. In the case of isentropic unloading, a non-stationary flow with a non-linear refractive index dependence is formed in the window, which can lead to significant changes in the correction factor. Currently, the change in the refractive index under non-stationary flows in crystals has not been studied in sufficient detail [4].

On the shock adiabat, the apparent and true mass velocities are linearly related with a constant correction factor. In the paper [5] it was found that in the region of isentropic unloading, the linear character between the velocities is violated.

In this work, the contact boundary profiles of the sample-window were analyzed in experiments with the compression of lithium fluoride using flat impactors of different thicknesses in a wide range of velocities, as well as in experiments with flat and diverging detonation waves. It was found that in the problem with a diverging detonation wave, the change in the correction factor exceeds the similar change in the case of all flat problems by several times.

References

1. Experimental methods and means in the physics of extreme material states [Text] : monography / edited by R. I. Ilkayev, A. L. Mikhaylov, M. V. Zhernokletov. – M. : RAS Publishers, 2021 – P. 1–484

2. **Huang, J. W.** Refractive indices of Gd3Ga5O12 single crystals under shock compression to 100–290 GPa [Text] // Journal of Applied Physics. – 2015. – Vol. 118, No. 20. – P. 1–4.

3. **LaLone, B. M.** Velocity correction and refractive index changes for [100] lithium fluoride optical windows under shock compression, recompression, and unloading [Text] // Journal of Applied Physics. –2008–Vol. 103 – P. 093505.

4. **Hawreliak, J. A.** Shock-induced melting of [100] lithium fluoride: Sound speed and Hugoniot measurements to 230 GPa [Text] / J. A. Hawreliak, J. M. Winey, Y. Toyoda, et al. // Phys. Rev. B. – 2023. – Vol. 107 – P. 014104.

5. **Krasilnikov, A. V.** Studying the correction factor of a lithium fluoride crystal during its shock compression and isoentropic unloading [Text] / A. V. Krasilnikov, E. I. Nesmiyanov, E. S. Shestakovskaya, et al. // Bulletin of the South Ural State University. Ser. "Mathematics. Mechanics. Physics". – 2024. – Vol. 16, No. 4. – P. 96–106.