Molecular dynamic simulation of laser shock waves in aluminum crystals

Perov E A[1,@], Doludenko A N[1], Shepelev V V[2], Petrov Yu V[3], Inogamov N A[3,4], Zhakhovsky V V[1,4] and Fortova S V[2]

[1] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia
[2] Institute for Computer-Aided Design of the Russian Academy of Sciences, Vtoraya Brestskaya 19/18, Moscow 123056, Russia
[3] Landau Institute for Theoretical Physics of the Russian Academy of Sciences, Akademika Semenova 1a, Chernogolovka, Moscow Region 142432, Russia
[4] Dukhov Research Institute of Automatics (VNIIA), Sushchevskaya 22, Moscow 127055, Russia

[@] eugenie051296@mail.ru

Ultrashort (femtosecond) high-power laser exposure causes irreversible changes in the crystal lattice at some depth from the heating layer. When the part of the shock wave responsible for plastic deformations attenuates, the hardening stops. These changes are the basis of laser hardening technology [1]. A purely elastic wave does not have any benefit for hardening. The impact of the laser-induced shock wave is modeled using the molecular dynamics method. The paper shows at what depth the separation of the initial high-pressure plastic wave into two waves (plastic and elastic) takes place [2]. The work also demonstrates three stages of the shock wave shape–a plane shock wave, the bending of a plane wave, when the side unloading waves begin to approach the axis of symmetry, and when the wave front becomes semispherical–after that the shock wave attenuates rapidly [3].

[1] Y R Kolobov E V Golosov T N V e a 2015 *Applied Physics A* **119** 241–247
[2] Inogamov N A, Perov E A, Zhakhovsky V V, Shepelev V V, Petrov Y V and Fortova S V 2022 *JETP Letters* **115** 71–78
[3] V V Shepelev Yu V Petrov N A I V V Z E A P S V F 2022 *Optics and Laser Technology* **152** 108110