The directivity patterns of laser ultrasound in a diamond anvil cell

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The laser ultrasonics (LU) in a diamond anvil cell (DAC) is used for measuring the elastic properties of materials under high pressure. LU-DAC technique can use the schemes "point-source-point-receiver" [1] and "line-source-point-receiver" [2] and is based on the application of sharply focused radiation of sub-nanosecond laser for the generation of the acoustic pulses. In this work we present the analytical theory describing the directivity patterns of laser ultrasound generated via thermo-elastic effect at solid/solid interface. This theory assumes the use of sub-nanosecond laser pulses and two materials in contact - an opaque material and a transparent material. Under these conditions, the equations, which describe the profiles of the longitudinal and shear waves at different angles of propagation, are obtained. Using the general theoretical solutions, the directivity pattern for the ultrasound emitted from a mechanically free surface of iron is constructed. These results are in good agreement with earlier investigations [3,4]. Then the directivity pattern for iron in DAC at different pressures is obtained. The predictions of the analytical theory are compared to the results obtained by numerical modeling [4]. To do this the directivity pattern for aluminum in DAC and for free surface of aluminum are also obtained. Experiments to validate the analytical theory are planned.
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