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激光与光电子技术应用

基于应力-位移混合有限元法的激光超声数值模拟

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摘要： 为了研究激光辐照各向同性半无限大铝材料内超声波的激发和传播特征，采用理想匹配层和应力-位移混合有限元方法建立了半无限大介质中激光激发超声波的有限元数值模型。模拟研究了各向同性半无限大铝材料内激发产生的瞬态波场图和垂直表面位移，并与相同几何模型下采用有限元方法得到的结果进行了对比分析。结果表明，应力-位移混合有限元方法能够有效地消除模型截断边界处的反射波，精确地模拟出无限大固体材料内激光激发超声波的产生和传播特性。数值模拟结果为进一步研究微纳米薄膜材料中皮秒或飞秒激光激发超声波提供了有效的方法。

关键词： 激光技术 激光超声 理想匹配层 混合有限元 数值模拟

Mixed stress-displacement finite element method for laser-generated ultrasound

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Abstract: In order to study the generation and propagation of laser-generated ultrasound in isotropic semi-infinite aluminum material, a laser-generated ultrasound in an arbitrary elastic semi-infinite medium model was established by using mixed stress-displacement finite element method and perfectly matched layer(PML). The transient wave snapshots and surface normal displacement waveforms in semi-infinite aluminum materials were obtained. The surface normal displacement waveforms were compared with the same geometrical finite element model. The results show that the mixed stress-displacement finite element method can effectively eliminate reflection waves from truncated boundary, and simulate the generation and propagation of ultrasound in semi-infinite solid material accurately. The simulation results provide an effective method for research of the laser-generated ultrasound waves in micro-nanostructure by picosecond or femtosecond laser irradiation.

Keywords: laser technique laser-generated ultrasonic perfectly matched layer mixed finite element method numerical simulation

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