

## 激光与光电子技术应用

### 激光辐照材料表层温升规律的数值模拟

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摘要:

为了在烧蚀机制下的激光超声检测中合理加载激光能量,获得幅值较大的超声信号而不过于损伤被检材料,需要分析激光辐照材料表层的温升规律及激光烧蚀的问题。建立了激光辐照材料的理论模型,激光以热流密度的形式加载于材料表面。结合导热微分方程,将对流传热和辐射传热一同考虑,并在材料表层升温过程中有效处理了相变潜热,对材料表层受激光辐照的温度场进行了数值模拟。给出了激光烧蚀材料有限元分析的程序流程,选择45<sup>#</sup>钢坯为例进行激光辐照仿真计算,分析了钢坯表层受激光辐照区域、区域下方及区域边界附近节点的温升规律,并对比钢坯受激光辐照的实际烧蚀情况和通过采集激光超声波信号进行了验证。结果表明,数值模拟能够为后续热应力分析中载荷的加载提供依据,并为激光超声检测中激光能量的加载提供了参考。

关键词: 激光技术 激光超声 有限元分析 温升规律 激光烧蚀

### Numerical simulation of temperature rise of material surface irradiated by the laser

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Abstract:

In order to load laser energy reasonably in the laser ultrasonic testing under the ablation mechanism and obtain large amplitude of ultrasonic signal without damaging the detected material, temperature rise and laser ablation of material surface irradiated by laser were analyzed. Theory model of laser irradiating material surface was established and laser was loaded on the material surface by the form of heat flux. By combining heat conduction differential equation with the boundary condition of convective heat transfer and radiation heat transfer, the latent heat in the material surface during the heating process was dealt with effectively and numerical simulation of temperature field of material surface irradiated by laser was made. The program flow of laser ablating material finite element analysis was given out. Taking 45<sup>#</sup> billet for example, laser irradiation simulation was made. The temperature rise law of the nodes of the irradiated area, of the lower area and near the boundary was analyzed. Contrasting with the actual ablation by laser irradiation and collecting the laser ultrasonic signal, the verification was made. The results show that numerical simulation provides the basis for the load during the finite element thermal stress analysis and the reference for the loading of the laser energy during the laser ultrasonic test.

Keywords: laser technique laser ultrasonic finite element analysis law of temperature rise laser ablation

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