应用光学 2009, 30(2) 325-329 DOI: ISSN: 1002-2082 CN: 61-1171/O4

论文

飞秒激光辐照下单晶硅薄膜中超快能量输运的数值模拟

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摘要：

利用载流子输运模型对飞秒激光辐照下单晶硅亚微米薄膜中的能量输运过程进行数值模拟。研究了不同辐照能量密度和不同激光波长对载流子密度和温度超快变化过程的影响规律。结果表明，在800nm激光辐照下，不同入射能量密度仅影响载流子密度和温度响应的峰值，但达到峰值的时刻不变。平衡态的恢复过程受入射能量密度影响很小。在不同波长激光辐照下，光子能量越大，载流子密度和温度达到峰值所用时间越短，对应峰值越大，但衰减速度也越快。当入射光子能量大于单晶硅的直接带隙时，快速衰减时间常数可以与载流子能量弛豫时间相当。

关键词： 飞秒激光 能量输运 数值模拟 单晶硅薄膜

Numerical simulation of ultrafast energy transport in monocrystalline silicon films under femtosecond laser irradiation

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Abstract:

The process of the ultrafast energy transport in monocrystalline silicon sub micron films irradiated with femtosecond laser was simulated using the carrier transport model based on the Boltzmann transport equation. The effects of different irradiation energy density and laser wavelength on the carrier density and the process of temperature ultrafast variation were investigated. The numerical calculation results show that, irradiated at 800 nm, the incident energy density influences the peaks of the carrier density and temperature only, but the occurrence time of their peaks does not change. The recovery process toward the equilibrium state is hardly influenced by the incident energy density. Under the irradiation of different wavelengths, the higher the photon energy is, the less time the carrier density and temperature take to reach the peak values, the bigger the corresponding peak appears and the faster the attenuation velocity becomes. The time constant of the fast attenuation is equal to the carrier energy relaxation time when the incident photon energy is larger than the band-gap of the monocrystalline silicon.

Keywords: femtosecond laser energy transport numerical simulation monocrystalline silicon film

收稿日期 1900-01-01 修回日期 1900-01-01 网络版发布日期

DOI:

基金项目:

通讯作者: 刘国栋

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参考文献：

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