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碲镉汞光导探测器在中红外激光测量中的热问题

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Thermal issues of photoconductive HgCdTe detector in mid-infrared laser parameter measurement

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摘要 图/表 参考文献 相关文章 (15)

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摘要 为了准确测量中红外高能激光系统的远场功率密度时空分布等参数,分析了室温光导型碲镉汞(HgCdTe)探测器在环境温度变化和光热效应情况下存在的探测器光敏元温升等热问题,并分别给出了应对措施.从HgCdTe的电学参数经验公式和光导型探测器工作原理出发,分析了暗电阻和响应率与光敏元工作温度的相关性.建立了计入接触热阻和自然对流效应的光导型HgCdTe探测器热分析模型,并对模型进行了实验验证.分析了光敏元与环境温度间的热平衡时间特性,提出了连续激光测量中的环境温度校正模型.讨论了激光辐照下探测器的动态响应特性,给出了激光加热探测器光敏元导致的附加光热信号的修正方法,该方法在典型应用条件下可将测量系统的单通道测量不确定度降低2%以上.目前,所述方法均已成功应用于多套远场激光光斑定量测量系统.

关键词 : 激光参数测量, 激光能量测量, 中红外激光, HgCdTe光导探测器, 热信号修正

Abstract : To measure accurately the spatial and temporal distribution of laser intensity in a far-field for a mid-infrared high energy laser system, two thermal issues existing in laser parameter measurement for an uncooled photoconductive HgCdTe detector were discussed, including environmental temperature variation and the laser induced temperature rise of a sensor chip. Then, two solution schemes were presented respectively. On the basis of empirical formulas for electrical properties of n-type HgCdTe materials and device physics of the photoconductor, the temperature dependences on dark resistance and responsivity were analyzed. A thermal analysis model of the photoconductive HgCdTe detector was established and verified by experimental data. Thermal contact resistance and natural convection were considered in this model. After the time characteristics of thermal equilibrium between sensor chip and environment were investigated, an environmental temperature calibration model for continuous wave laser parameter measurement was presented. Finally, dynamic responses of the HgCdTe detector under fixed and variational laser irradiations were analyzed, and a correcting method for the effect of laser heating on sensor chip was presented. The results show that the measurement uncertainty of a single unit in the beam detector array is reduced by 2% or more under a typical implementing condition. The proposed methods have been successfully used in different mid-infrared high energy laser quantificational measurement systems.

Key words : laser parameter measurement laser energy measurement mid-infrared laser HgCdTe photoconductor detector thermal signal correction

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