

激光物理与激光器件

高平均波长稳定性超荧光光纤光源

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摘要: 光纤陀螺要求其光源具有高功率、宽谱输出, 同时在大温度范围内仍具有好的平均波长稳定性。为了满足-45℃~70℃大温度范围的应用需求, 采用双程后向抽运、法拉第旋转反射、带通滤波等技术手段, 对光纤材料和器件进行大温区全局优化, 以改善超荧光光纤光源的平均波长稳定性。理论分析了不同中心波长和带宽的带通滤波器以及光纤长度等参量对平均波长稳定性的改善效果, 以及和光谱带宽的关系。按照设计结果选择滤波、光纤长度等参量, 通过对-45℃~70℃全温区范围进行系统全局优化设计, 得到输出功率为32mW, 功率稳定性为0.65%, 光谱带宽为12.5nm, 光源平均波长变化量为 23.5×10^{-6} 。结果表明, 平均波长稳定性在 $0.5 \times 10^{-6}/\text{℃}$ 以下的高稳定性超荧光光纤光源中, 32mW输出功率非常高; 所得的 $0.2 \times 10^{-6}/\text{℃}$ 是115℃大温差范围、30mW以上超荧光光纤光源中非常优异的平均波长稳定性指标, 满足光纤陀螺对光纤光源的要求。

关键词: 光纤光学 超荧光光纤光源 光纤滤波器 双程后向结构 平均波长稳定性

A superfluorescent fiber source with high mean wavelength stability

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Abstract: Interferometric fiber-optic gyroscopes require the optical sources should have high output power, broad bandwidth, as well as good mean wavelength stability within a large temperature range. To meet the temperature demands from -45℃ to 70℃, a bandpass filter as well as a Faraday rotation mirror was incorporated in the double-pass backward Er-doped superfluorescent fiber source, which, together with the optimization of the performance of fiber and other optical components in such a large temperature range, improved the output mean wavelength of the superfluorescent fiber source a lot. The effects of filters with different central wavelengths and bandwidths, as well as fiber length on mean wavelength stability and output bandwidth were modeled. Based on the simulation result about bandpass filters and fiber length, after optimizing the whole superfluorescent fiber source, the output power reached 32mW; the output bandwidth was 12.5nm. From -45℃ to 70℃, the mean wavelength variation of the superfluorescent fiber source was controlled to 23.5×10^{-6} , and the output power variation was 0.65%. According to the investigation, among all superfluorescent fiber sources with mean wavelength stability lower than $0.5 \times 10^{-6}/\text{℃}$, the 32mW output power is pretty high; the thermal coefficient of $0.2 \times 10^{-6}/\text{℃}$ is also an excellent result reported for a whole superfluorescent fiber source with output power above 30mW in the 115℃ temperature range, which satisfies the demands of interferometric fiber-optic gyroscopes.

Keywords: fiber optics superfluorescent fiber source fiber filter double-pass backward configuration mean wavelength stability

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