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A fiber thermal sensor based on phase-lock loop and fast fourier transform

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Abstract

A sapphire fiber thermal probe with Cr^{3+} ion-doped end is grown by using the laser heated pedestal growth method. The fluorescence thermal probe offers advantages of compact structure, high performance and ability to withstand high temperature in a detection rang from room temperature to 450℃. Based on the Fast Fourier Transform (FFT), the fluorescence lifetime is obtained from the tangent function of phase angle of the non-zeroth terms in the FFT result.

This method has advantages such as quick calculation, high accuracy and immunity to the background noise. This FFT method is compared with other traditional fitting methods, indicating that the standard deviation of the FFT method is about half of that of the Prony method and about 1/6 of that of the log-fit method. The FFT method is immune to the background noise involved in a signal, so that the process of signal processing by the FFT method can be advanced. In addition, a phase-lock amplifier can effectively suppress the noise.

Key words: *Fluorescence thermometer, Fast Fourier Transform, Phase-lock loop, Sapphire optical fiber*

1. Introduction

In recent years, the technique of the fiber-optic temperature measurement in fluorescence has aroused the interest of all (Sun *et al.*, 2002). It can be applied to the microwave heating in medical treatment or internal temperature-monitor in large transformers in which the conventional temperature sensors are hard to use. The fluorescence lifespan of metal-ion-doped ceramic reduces exponentially with the increase of the temperature, based on which a temperature-sensing device can be developed. Essentially, the relation between the fluorescence lifespan and the temperature is inherent and irrelevant to light

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