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压力敏感涂料特性及其校准技术实验研究

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Experimental Research of Pressure Sensitive Paint Performance and Calibration Technique

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摘要

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摘要

精细化的校准技术和涂料特性研究是影响压力敏感涂料(PSP)测量技术测量精度及其工程应用的重要因素。为此以PSP地面实验测量系统为主要平台,进行了国产PSP的静态校准和光降解实验,基于自主编制的PSP静态校准图像后处理程序研究了PSP压力、温度灵敏度之外所展现出重要特性。研究表明:一定压力范围内,PSP的Stern-Volmer响应曲线呈现出较为明显的非线性,在校准中应采取高阶Stern-Volmer关系式进行拟合;在均匀压力和温度下,不同样片区域的校准结果呈现出空间不均匀性,这种不均匀性会影响PSP的校准精度;PSP存在光降解效应,其降解曲线在一定时间内近似为线性。同时,本文还简要分析了其产生机理以及对PSP测量精度的影响,初步提出了相应的评估指标及改进措施。

关键词: 压力敏感涂料 静态校准 涂料特性 压力响应非线性 空间不均匀性 光降解

Abstract:

Calibration technique and paint performance research are critical for improving the measurement accuracy and engineering application of pressure sensitive paint (PSP). In this paper, static calibration and photo-degradation experiments are performed based on a PSP static calibration setup and image post-processing software which is programmed independently to study paint performances other than its pressure and temperature sensitivity. The results of this study reveal that the Stern-Volmer curve of PSP exhibits a nonlinear characteristic rather than following the conventional linear pattern, which is approximated with a polynomial function using curve-fitting analysis. Moreover, calibration results of the painted coupon vary in space although the experiment is performed under uniform pressure and temperature, and it tends to decrease calibration accuracy. Finally, PSP demonstrates a photo-degradation characteristic and the degradation curve is approximately linear within a range of time. Evaluation indices of pressure response nonlinearity, calibration spatial non-uniformity and photo-degradation are proposed while their mechanisms of production, influences on PSP measurement accuracy and correction methods are also presented.

Keywords: pressure sensitive paint static calibration paint performance nonlinear pressure response spatial non-uniformity photo-degradation

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