Film thickness effects on calibrations of a narrowband thermochromic liquid crystal

ABSTRACT

Thermochromic liquid crystals (TLCs) have been widely employed by researchers in heat transfer and fluid flow communities as a reliable and non-intrusive temperature measurement tool due to their unique optical properties such as birefringence, optical activity, circular dichroism and selective reflection of colours in the visible spectrum as function of temperature. The use of narrowband TLCs are attractive for temperature and heat transfer measurements due to their higher precision in temperature measurements and due to the fact that narrowband TLCs are less affected by variations in illumination-viewing angles and illumination disturbances. Narrowband TLCs have been used with full intensity-matching methods to provide robust image processing for measurements of thermal parameters in transient heat transfer tests. Calibration of narrowband TLCs is necessary in order to obtain the intensity-temperature relationship of the TLCs. Film thickness is one of the factors which affects calibrations of TLCs. In this research, film thicknesses of 10, 20, 30, 40 and 50 μm were investigated on green intensity-based calibrations of R35C1W TLC during heating and cooling. Results showed an increase in magnitude of peak green intensity with increasing film thickness, with a percentage increase of nearly 18% when film thickness increased from 10 to 50 μm. Results also showed an inconsistent shift in temperature at which peak green intensity occurs, with a maximum shift of 0.40 °C, suggesting that film thickness effects may be insignificant for narrowband TLCs compared with wideband TLCs. A theoretical method for estimating the volume of TLC coating required to achieve a desired film thickness has also been described in this paper, based on the surface area and dry solids content of the TLC. The method is easily implemented and applicable for sprayable TLC coatings.

Keyword: Thermochromic liquid crystal, Intensity calibration, Film thickness, Heat transfer