OPTICAL DIFFERENTIAL TEMPERATURE MEASUREMENT WITH BEAT FREQUENCY PHASE FLUOROMETRY

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We present a new method for differential temperature measurement based on thermal sensitivity of the fluorescence lifetime of thermographic phosphors (TP). Pairs of thermographic phosphors are excited with intensity modulated light at frequencies ω and ω+Δω. The phase shift Δθ of the summary fluorescence intensity beat signal envelope is measured. It depends on temperature difference between TP and allows differential temperature measurement.

A prototype of fluorometric differential temperature sensor (Fig. 1) was developed and feasibility of the method is experimentally demonstrated with a Sm^{2+}:SrFCl crystal and the $_5D^1 \rightarrow {}_7F^0$ transition for high thermal sensitivity. The observed linear dependence between envelope phase shift Δθ and temperature difference ΔT agrees with the theoretical prediction. Sensitivity of S = -1 °/°C was achieved (Fig. 2). This method could also be applied to differential measurements of any parameter affecting fluorescence lifetime.

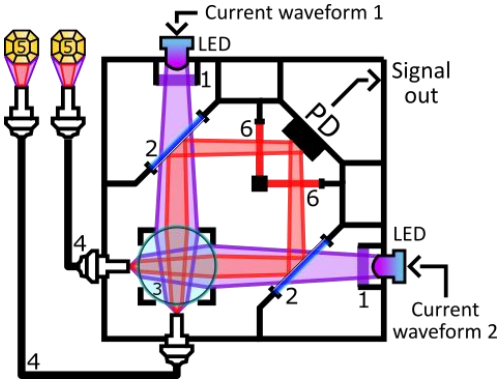

Fig.1 Schematic of the optical temperature sensor that shows mutual position of the LEDs, excitation filters (1), dichroic mirrors (2), quartz spherical lens (3), optical fibers (4), Sm2+:SrFCl crystals (5), fluorescence interference filters (6) and photodiode within anodized aluminum frame.

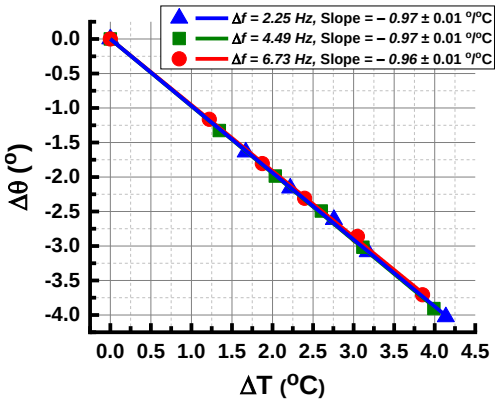

Fig. Measured Δθ(ΔT) in the case of Δf=2.25 (blue), 4.49 (green) and 6.73 (red) Hz. R2 of linear fit = 0.9988.

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