International Conference on Advanced Optical Technologies
University of Erlangen-Nürnberg, March 13th – 15th 2019

Temperature measurements using laser-induced phosphorescence of luminescent particles

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The optimization of many processes in power and process engineering requires the determination of temporally and spatially resolved temperature fields. Thermographic phosphor particles cover a broad temperature range and they may be applied for both surface and gas phase temperature measurement [1]. In gaseous flows, phosphor particles can also act as PIV (particle image velocimetry) tracers to determine flow velocities simultaneously [2].

The luminescence emission characteristics and the thermal sensitivity of the phosphor material are strongly dependent on a variety of influencing factors such as dopant type and concentration, host matrix, particle size or chemical and physical environment. Therefore, a precise calibration and an investigation of potential systematic errors are indispensable. This work concentrates on the characterization and optimization of the high temperature phosphor YAG:Dy. Special emphasis was placed on the material-specific properties such as dopant concentration as well as on the influence of the ambient conditions.

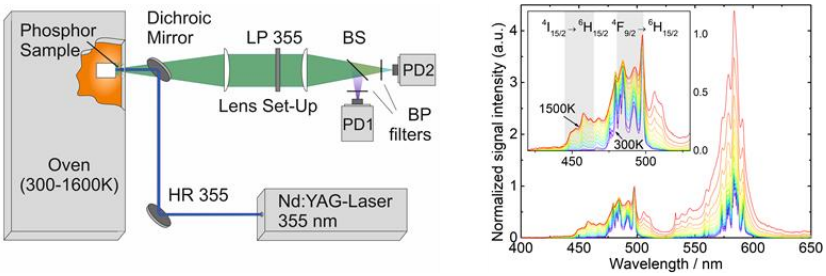

Figure 1. Experimental set-up used for phosphor emission characterization (left) and temperature dependent spectral emission behavior of YAG:Dy^{3+}.

We characterized the luminescent properties of the thermographic phosphor particles YAG:Dy(3%),Er(0.5%) both for bulk powders and dispersed particles. High temperature emission measurements up to 1600 K were conducted for the bulk material in a high-temperature oven. The particles were excited with a Nd:YAG laser at 355 nm, and temperature dependent emission spectra and the lifetime data of the phosphor material were recorded. Particle size effects and the influence of a variation of the dopant ions on spectral emission, luminescence lifetime and absolute intensity were studied. Additionally, the luminescent particles were seeded to the gas flow in a calibration cell. The seeding density and the laser fluence had negligible effects on the estimated temperature.

References

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