Interlaboratory comparison on absolute photo-luminescence quantum yield measurements of scattering luminescent materials

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An interlaboratory comparison (ILC) of three laboratories from academia and industry is performed to identify and quantify sources of uncertainty of absolute photoluminescence quantum yield (QY) measurements of scattering samples. While the QY of transparent luminescent materials are usually determined relative to a reference dye or standard of known QY [1], the determination of QY of scattering liquid and solid samples such as dispersions of luminescent nanoparticles, solid phosphors, and optoceramics requires, however, absolute measurements with an integrating sphere setup. Although the importance of reliable absolute QY measurements has been recognized, an ILC on suitable measurement geometries and achievable measurement uncertainties have not been reported yet. Such interlaboratory comparisons involving different setups and staff also provide the basis for identifying and quantifying typical instrument- and method-inherent sources of uncertainty.

Two types of commercial stand-alone integrating sphere setups with different illumination and detection geometries are used for measuring QY of transparent and scattering dye solutions as well as solid phosphors. As representative and industrially relevant samples, YAG:Ce optoceramics of varying surface roughness are chosen. These materials are applied, e.g., as converter materials for blue light emitting diodes. Special emphasis is put on the influence of the measurement geometry, the optical properties of the blank (used to determine the number of photons of the incident excitation light absorbed by the sample), and the sample-specific surface roughness. Matching QY values are obtained for transparent dye solutions and scattering dispersions, here utilizing a blank with scattering properties closely matching those of the sample. However, QY measurements of optoceramic samples revealed substantial differences for different blanks with measurement uncertainties of exceeding 20 %. Based on these results, a non-absorbing blank material with a high reflectivity > 95 % such as a 2-mm thick PTFE target placed on the sample holder is recommended. The blank reveals a near-Lambertian light scattering behaviour, yielding a homogeneous light distribution within the integrating sphere.

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