Glass-based Reference Materials for Fluorescence Applications

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Introduction

Luminescence-based techniques are widely used as analytical tools in e.g. medical diagnostics, drug screening, in environmental and material analysis as well as for product and process control. Fluorescence methods yield relative signals which are affected also by instrument properties (wavelength accuracy, spectral irradiance reaching the sample, spectral responsivity of the emission channel (see Fig. 4)) and by their time-dependent fluctuations.[1] The increasing need for reliable and comparable data calls for easy-to-operate fluorescence standards in order to characterize and validate the performance of fluorescence instruments.[2-6] Here, fluorescent glasses have been studied as potential reference materials. The spectroscopic features and stability tests clearly demonstrate the suitability of these glasses as wavelength standards and day-to-day intensity standards.

Requirements on Fluorescence Standards

- measurable with routinely used instrument settings
- emission intensity and size of the radiating volume comparable to those of fluorescent samples
- absorption and emission in commonly used wavelength regions
- high fluorescence quantum yield, preferably independent of excitation and emission wavelength
- considerable Stokes shift to minimize a dependence of the emission on fluorophore concentration
- isotropic emission and negligible temperature dependence
- sufficient stability under application-relevant conditions

Results

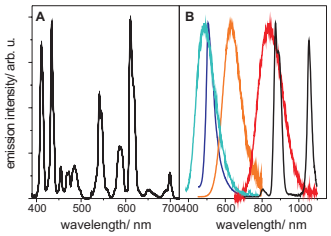


Figure 1
Narrow band-emitting glass, doped with a multitude of rare earth (RE) metal ions (A) and various broad band-emitting materials doped with transition metal ions (B), covering the VIS/NIR spectral region.

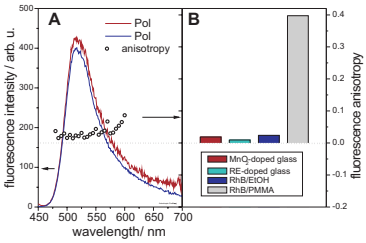


Figure 2
Emission anisotropy of inorganic-ion doped glass materials (A), compared to the anisotropy of a rhodamine dye in solution, and in a solid matrix (PMMA; Starna Inc.; B).

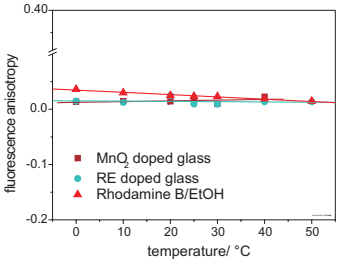


Figure 3
Temperature dependence of the emission anisotropy of inorganic-ion doped candidate glass reference materials.

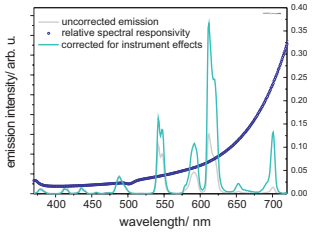


Figure 4
Effect of the correction for the instrument's spectral characteristics on the emission of a candidate fluorescence reference material doped with rare earth (RE) ions.

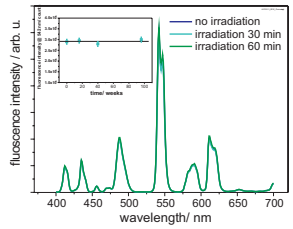
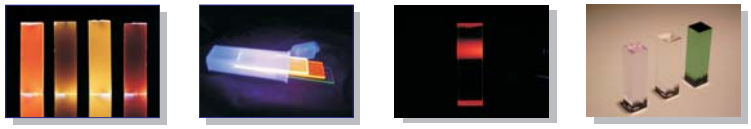


Figure 5
Photostability and long-term stability (inset) of inorganic-ion doped candidate glass reference materials.[6]



Summary

Candidate glass-based Reference Materials

- for the determination of the wavelength accuracy of fluorescence measuring systems with low spectral resolution (narrow band emitter)
- as spectral fluorescence standards, covering the VIS/NIR spectral range (broad band emitter)

Benefits of Glass-based Fluorescence Standards

- absorption and emission in usual wavelength regions (cf. Fig. 1)
- excitable with frequently used laser sources
- emission characteristics comparable to those of fluorescent samples due to their chromophore nature
- isotropic fluorescence emission (cf. Fig. 2)
- negligible temperature dependence (cf. Fig. 3)
- excellent photochemical and thermal stability (cf. Fig. 5)
- easy to use for different fluorescence techniques (e.g. in fluorescence spectroscopy and microscopy)

References

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(2) U. Resch-Genger, K. Hoffmann, A. Hoffmann in: Annals of the New York Academy of Science, Fluorescence inSpectroscopy, Imaging, and Probes: Methods and Applications, O.S. Wolfbeis, Ed. The New York Academy of Science, New York 2008, Vol. 1130, 35-43.
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