SCHOTT optical glasses for life-science applications

Ralf Jedamzik, Bernhard Hladik, Peter Hartmann

SCHOTT AG, Hattenbergstrasse 10, 55122 Mainz, Germany

mailto:ralf.jedamzik@schott.com

Optical glasses from SCHOTT fulfilling tight specifications regarding optical position, dispersion and fluorescence are a key factor in the design of lens systems for modern life science applications e.g. fluorescence- and CARS microscopy or DNA sequencing..

1 Summary

SCHOTT offers a wide range of optical glasses with tight specifications for the use in life-science applications.
The special short flint glasses N-KZFS4, N-KZFS5 and N-KZFS8 are among those glasses and offer a unique pronounced deviation of the partial dispersion from the normal line. Especially suited for the use in high-end apochromatic lens designs, they have also been specifically developed to highly transmit light in the blue violet range in combination with a remarkable low fluorescence at 365 nm excitation wavelength, which makes them to perfect candidates for fluorescence microscopy.
The fluorescence can be determined for a wide range of excitation wavelengths between 250 nm and 650 nm. The fluorescence of optical glasses is not only a function of the glass composition but also of the excitation wavelength and the production method.

2 KZFS glasses from SCHOTT as examples for special optical glasses for microscopy with tight specifications

Fluorescence microscopy and fast DNA sequencing are typical life-science applications with the need for glasses with low fluorescence at a broad range of fluorophore excitation wavelengths and tight optical specifications. A broad range of optical glasses are used e.g.:

- Low dispersion glasses (ED glasses) e.g. N-FK51A
- Glasses with anomalous partial dispersion for color correction e.g. N-KZFS4, N-KZFS5, N-KZFS8
- High refractive index glasses with high transmission in the blue are e.g. N-SF6HT, N-SF57HT but also N-LASF44
- Low Tg glasses for precision molding suitable for economical asphere production.

Glasses used in microscopy often have to fulfill tight specifications regarding optical position (step 1/1) and stress birefringence (typical < 6 nm/cm).

The special short flint glasses N-KZFS4, N.-KZFS5 and N-KZFS8 are among those glasses and they are good examples for a combination of optimized properties. First of all these glasses have a much stronger pronounced deviation of the partial dispersion from the normal line compared to the competition as can be seen in figure 1:

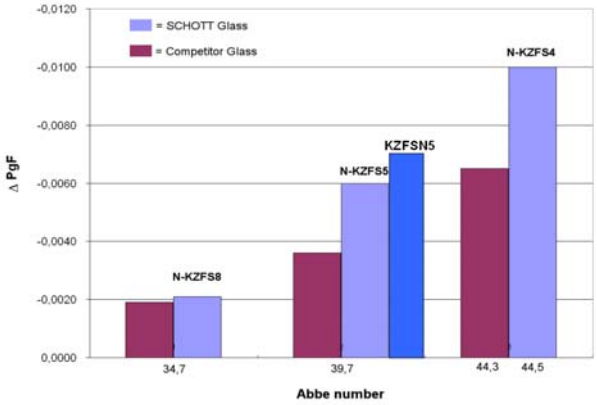

Fig. 1: *SCHOTT N-KZFS glasses deviate stronger from the normal line compared to competitor's materials*

Therefore these glasses are especially suited for apochromatic designs. They are frequently used in combination with SCHOTT's low dispersion Fluoro/Phosphate glass types like N-FK51A.

N-KZFS5 and N-KZFS8 also show a higher transmittance in the UV-blue spectral range compared to the competitor as can be seen in figure 2.

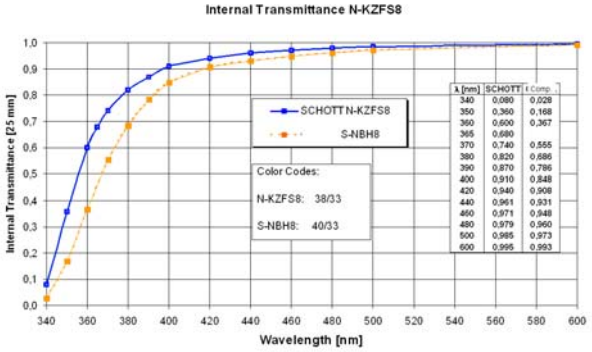

Fig. 2: *SCHOTT N-KZFS8 has a high transmittance in the UV-blue spectral range*

The fluorescence of the SCHOTT KZFS types is lower compared to the competitor materials over a wide spectral range. All KZFS glass types have a low Tg (Tg < 550°C) and have been qualified by SCHOTT to be suitable for the precision molding process.

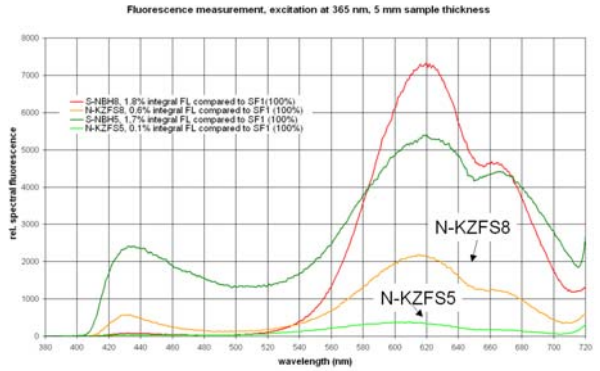

Fig.3: *SCHOTT N-KZFS glasses have a lower fluorescence compared to competitor's materials*.

3 Fluorescence characterization of optical glasses over a broad excitation and emission spectral range

SCHOTT uses a Jobin Yvon Fluorolog 3 fluorescence spectrometer for the characterization of fluorescence of optical glasses over a broad range of excitation and emission wavelengths. Our standard measurement direction is "front face" with excitation at normal incidence to the surface. The emission wavelength is measured in a direction tilted by ~28° from normal incidence. Measurement under 90° is also possible. The characterization of optical glasses for fluorescence microscopy can be performed at customer's specified excitation and emission wave length. The excitation wavelength range covers 250 nm to 650 nm. The emission wavelength ranges from 200 nm to 1500 nm.

The fluorescence of optical glasses strongly depends on the excitation wavelength. At 365 nm excitation lead free glass types (N-glasses) typically show lower fluorescence compared to lead containing types. At higher excitation wavelengths e.g. 532 nm the effect is inversed.

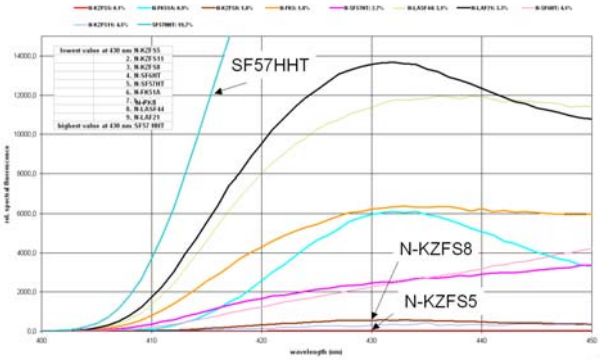

Fig. 4: *Fluorescence spectra at excitation 365 nm for different optical glasses.*

Figure 4 shows the fluorescence spectra of different optical glasses for an excitation at 365 nm. It can be seen that N-KZFS5 and N-KZFS8 have a much smaller fluorescence compared to SF57HHT in the given spectral range. In figure 5 it can be seen in contrast that the fluorescence of SF57HHT is lower at 532 nm excitation compared to the emission spectra of N-KZFS5 and N-KZFS8.

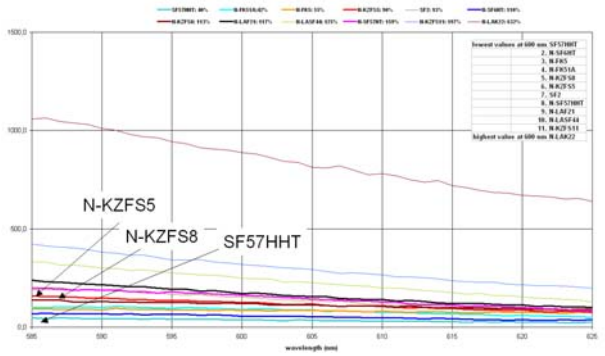

Fig. 5: *Fluorescence spectra at excitation 532 nm for different optical glasses.*

It should also be noted that the fluorescence of optical glasses can be influenced by the production method. In figure 6 the fluorescence of N-LASF44 at 365 nm excitation wavelength is shown for two different production methods. The fluorescence peak at 440 nm is strongly reduced using an alternative production method for the optical glass.

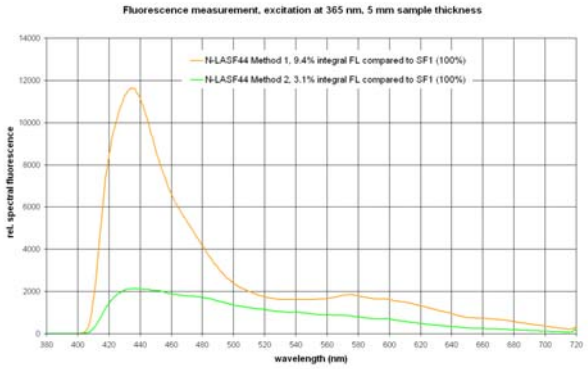

Fig. 6: *Fluorescence spectrum of N-LASF44 produced with different methods.*

The fluorescence of optical glasses is not only a function of the glass composition but also of the excitation wavelength and the production method. It is strongly recommended to precisely specify the excitation and emission wavelength range for the characterization of the glasses needed in an application.