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Using the FluoroMax® in the Near-IR

FL-16

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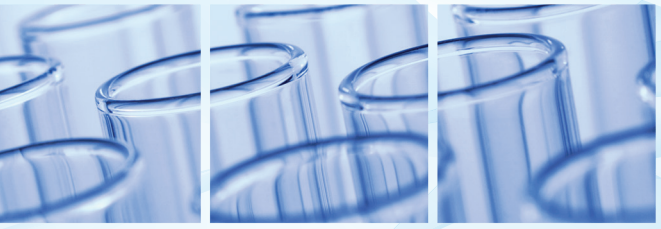
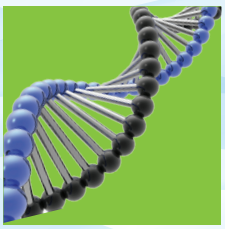
SPR IMAGING





Introduction

When the bench-top FluoroMax®-4 spectrofluorometer is fitted with our standard Hamamatsu R928P photomultiplier tube, the performance of this detector rapidly drops above 800 nm. With the rapid rise of nanoparticle and quantum-dot research in a variety of scientific fields, however, there is a growing interest in fluorescence measurements further into the near-IR.

The main problem with photomultiplier tubes as we venture into longer wavelengths is spontaneous emission from the photocathode, which increases the dark noise. This is why the R928P, for example, has a higher dark-noise background, than, say, the Hamamatsu R1527, which is often used to demonstrate a high signal-to-noise ratio, though it is poor at detecting signals with wavelengths longer than 600 nm. The answer is to cool the detectors as much as possible, thus lowering the dark noise, though this also affects their range.

If maximum dark-noise reduction is required, the modular Fluorolog® system is the obvious choice, because some of the most exotic detectors can be adapted to this modular configuration. How, though, can we increase the range of the FluoroMax® into the near-IR? To test the FluoroMax®'s response, we modified the FluoroMax®, and inside mounted a Hamamatsu R2658P, which has a range extending just beyond 1000 nm, and compared it to the R928P.

Near-IR performance comparison

Fig. 1 compares the spectra of a laser glass sample we normally use for IR calibration, run in a FluoroMax®-4 with a standard R928P and then an R2658P. Excitation was at 530 nm, with 5 nm excitation bandpass and 8 nm emission bandpass. Integration time was 0.1 s. A 550 nm long-pass filter removed stray excitation light. Spectra were corrected for dark noise.

Note that the R928P still dominates in sensitivity out to approximately 850 nm. Beyond 850 nm the R928P plummets precipitously, while the R2658 dominates. In fact, by 900 nm, the quantum efficiency of the R928P is virtually zero. The R2658 also gives surprisingly respectable performance throughout the visible and UV, as shown in a comparison of the standard sensitivity test of water Raman spectra (Fig. 2) in a FluoroMax®-4. Excitation was at 350 nm with 5 nm excitation and emission bandpasses and 0.1 s integration time.

Conclusions

If the region from 850 nm to 1010 nm is important to your work, then the R2658 is an indispensable detector. A water Raman spectrum with the R2658 yields a peak intensity of almost 150 000 counts/s, which is still better than almost any other spectrofluorometer— except a standard FluoroMax® or Fluorolog®.

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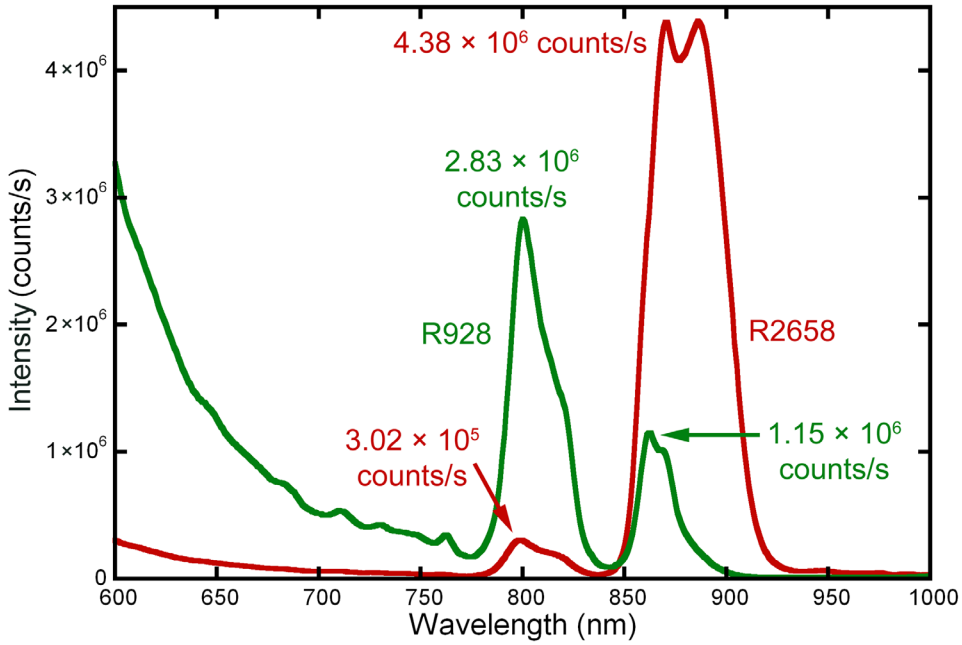

Fig. 1. Comparison of spectra from a laser glass taken with R928 and R2658 photomultiplier tubes in a FluoroMax®-4. λ_{exc} = 530 nm; bandpass = 5 nm excitation and 8 nm emission; integration time = 0.1 s; 550 nm long-pass filter on emission; correction for dark noise.

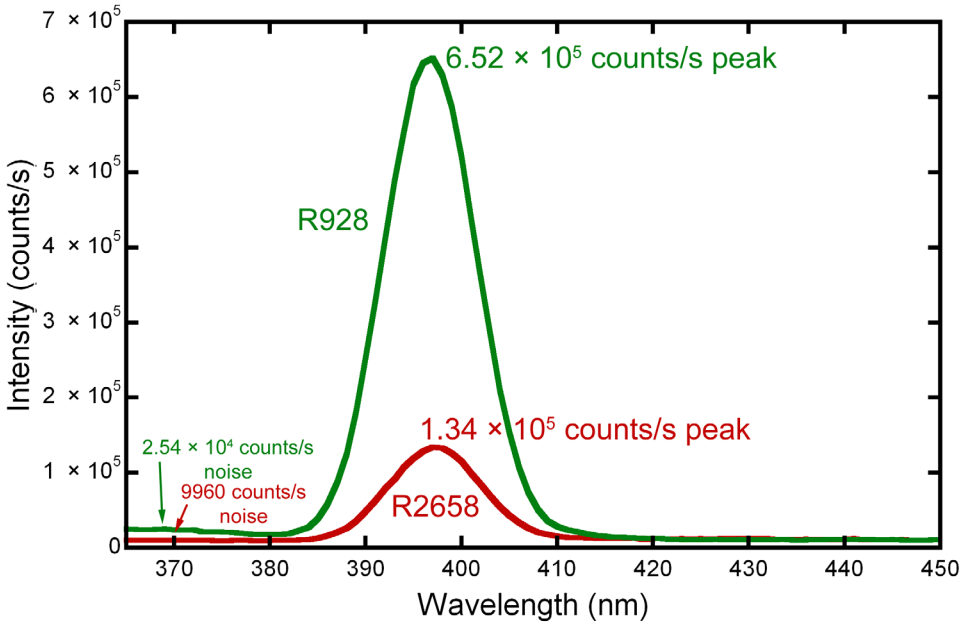

Fig. 2. Water-Raman spectral comparison between R928 and R2658 photomultiplier tubes in a FluoroMax®-4. water Raman peak. Integration time = 0.1 s; λ_{exc} = 350 nm; all bandpasses = 5 nm; high voltage for R928 = 950 V; high voltage for R2658 = 1500 V.

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