HORIBA Scientific

ELEMENTAL ANALYSIS
FLUORESCENCE
GRATINGS & OEM SPECTROMETERS
OPTICAL COMPONENTS
FORENSICS
PARTICLE CHARACTERIZATION
RAMAN
SPECTROSCOPIC ELLIPSOMETRY
SPR IMAGING

Increase sensitivity and suppress etaloning in your data

Etalon Fringe Suppression with the QExtra™ BIDD Camera

Introduction

Back-illuminated CCDs exhibit increased sensitivity and quantum efficiency because incident photons interact directly with the photosensitive silicon substrate without having to penetrate an electrode layer (as is the case of a front-illuminated CCD). However, back-illuminated CCDs suffer from optical fringes caused by interferences with wavelengths in the visible to near-IR spectral region. This effect is called *etaloning*. Briefly, the etaloning effect seen in traditional back-illuminated CCDs arises from the transparency of silicon at longer wavelengths (650–1100 nm). This transparency leads to reflections between the silicon and silicon dioxide layers, which form a resonant optical cavity leading to constructive and destructive interference. The end result is a standing-wave pattern, which appears in the signal as oscillations—which cannot be easily subtracted—superimposed on the desired data.

Solutions with QExtra™ technology

HORIBA Scientific introduces QExtra™ technology for its back-illuminated Synapse and Symphony II CCDs (with thermoelectric cooling and liquid-nitrogen cooling, respectively). QExtra™ technology uses an anti-reflective multi-layer coating to improve significantly the quantum efficiency over a broad spectral range while minimizing undesirable etaloning effects. Fig. 1 reveals the improvement in quantum efficiency of QExtra™ technology over basic back-illuminated deep depleted (BIDD) cameras currently available on the market. The increase in sensitivity

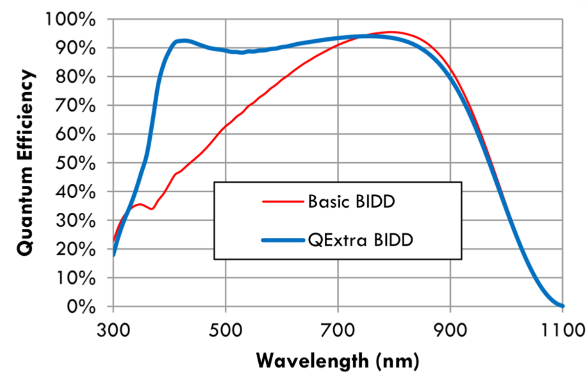

Fig. 1. Typical quantum efficiency of QExtra™ BIDD (blue) compared to a basic, back-illuminated, deep-depleted camera (red) at 25°C.

offered by QExtra™ technology makes HORIBA Scientific BIDDs the ideal scientific cameras for spectroscopy measurements.

In addition, the fringing effect seen in other BIDD cameras is suppressed with the new QExtra™ BIDD CCD. Fig. 2 compares a recorded spectrum of a

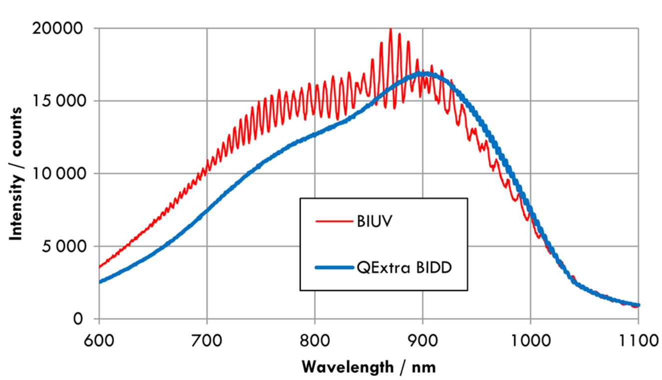

Fig. 2. Quartz tungsten-halogen lamp spectra recorded with BIUV (red) and QExtra™ (blue) cameras comparing etaloning effects.

quartz tungsten-halogen lamp acquired with a back-illuminated UV-coated CCD and the new QExtra™ BIDD Synapse camera. The etaloning effects are dramatic in the back-illuminated camera (red curve), causing large oscillations beginning at ~650 nm and extending into the near-IR wavelengths. The QExtra™ BIDD camera (blue curve) greatly suppresses etaloning effects, producing a clean, smooth spectrum typical of a quartz tungsten-halogen lamp. Typically, the extent of modulation caused by the etalon effect ranges anywhere from 1–10%. Outside of the etaloning region, the CCD spectrum remains flat.

Etaloning effects may be observed in imaging applications as well. In cases where imaging is carried out at shorter wavelengths or with lower resolution, etaloning effects are not seen. At shorter wavelengths, the silicon is no longer transparent and at lower resolution, the etaloning effects become averaged out in the final measurement. However, in cases where higher resolution is required or measurement is carried out at longer wavelengths, etaloning becomes prevalent (Fig. 3.) The Synapse QExtra™ BIDD camera does not suffer from such a fringe pattern when recording images.

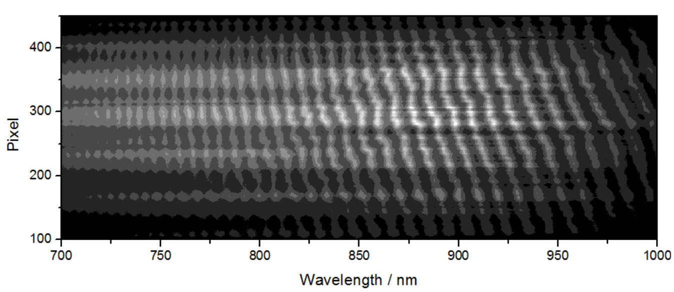

Fig. 3a. Fringe pattern observed in an image recorded with a back-illuminated CCD.

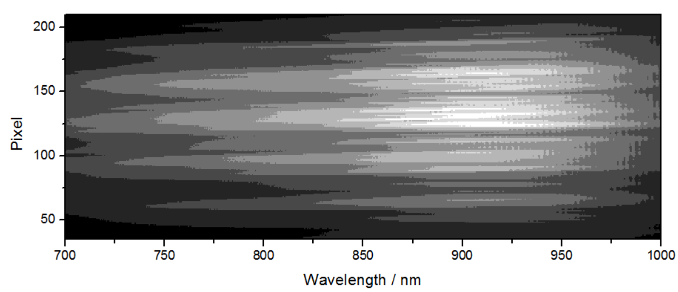

Fig. 3b. Fringe-suppression observed in an image recorded with a deep depleted back-illuminated CCD.

Conclusions

For applications at low levels of light from 600–1100 nm, such as Raman and photoluminescence experiments, HORIBA Scientific's QExtra™ cameras (Fig. 4) provide the highest sensitivity available with the added advantage of fringe-suppression compared to other back-illuminated CCDs.

Fig. 4. HORIBA Scientific's Synapse™ camera, which incorporates our QExtra™ technology.