

CASE STUDY:

DNA Purity Instruments

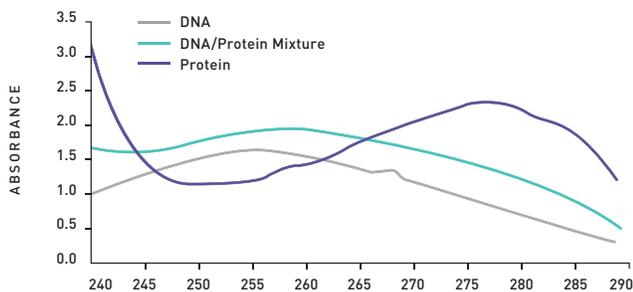
A leading manufacturer of life science instruments investigated the use of LEDs instead of xenon flash lamps in their spectrometers used for DNA concentration and purity measurements.

CHALLENGE

The extraction of DNA from cells and its purification are of primary importance to the field of biotechnology and forensics. Extraction and purification of DNA are the first steps in the analysis and manipulation of DNA that allow scientists to detect genetic disorders, produce DNA fingerprints of individuals, and even create genetically engineered organisms that can produce beneficial products such as insulin, antibiotics and hormones.

Quantitative analysis of DNA concentration and purity is based on UV absorption spectroscopy. Both DNA and protein absorb UV light, but have different absorption peaks at 260 nm and 280 nm respectively. The absorbances at these wavelengths determine the concentration of DNA and protein respectively, while the ratio of the absorbances determines the purity of the DNA sample.

ABSORBANCE SPECTRUM



Traditionally, UV lamps such as xenon flash or mercury have been used as light sources for these measurements since they have a broad spectrum and sufficient intensity in the desired wavelengths.

However, systems using xenon flash lamps as light sources tend to be expensive due to the cost of the lamp, the associated power supplies and complexity in design. While mercury lamp-based systems are cheaper, the mercury lamp requires a warm up time of up to 30 minutes and has poor light output stability.

MANUFACTURERS ARE SEEKING ALTERNATIVE LIGHT SOURCES, SUCH AS UVC LEDs, WHICH CAN BE TURNED INSTANTLY ON/OFF AND OFFER A LOWER COST OF OWNERSHIP TO THE END USER

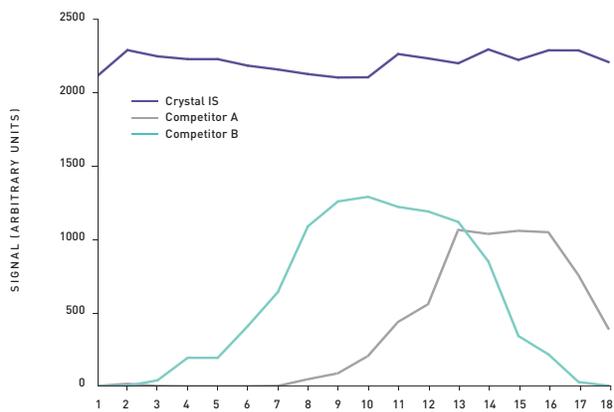
SOLUTION

Manufacturers are seeking alternative light sources, such as UVC LEDs, which can be turned instantly on/off and offer a lower cost of ownership to the end user. However, the initial UVC LED sources that were evaluated showed poor light stability during the measurement which significantly affected measurement accuracy. UVC LEDs from Crystal IS help overcome problems posed by traditional UV lamps and other commercial UVC LEDs.

An outside instrument manufacturer compared the stability of measurement at both 260 nm and 280 nm, between Crystal IS LED and other commercial LEDs. To reduce sample heating, the LED is pulsed on for 50 msec, a measurement is taken and then the LED turned off for 100 msec, and this measurement cycle is repeated fifty times and the average of the fifty measurements is determined.

Each data point on the y axis represents this average measured concentration of the DNA/protein mixture. To test stability of output from the light source, the manufacturer tested the same DNA/protein mixture multiple times using the 260 nm and 280 nm wavelengths.

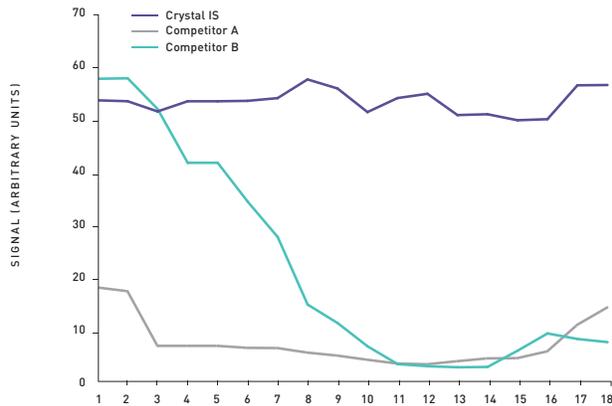
ABSORBANCE MEASUREMENT OF DNA/PROTEIN MIXTURE AT 260 NM





BY SWITCHING FROM XENON FLASH LAMPS TO UVC LEDS, MANUFACTURERS CAN REDUCE THEIR INSTRUMENT COST BY OVER 60%.

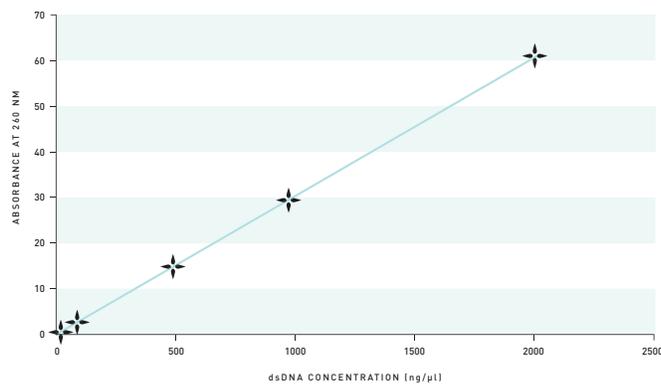
ABSORBANCE MEASUREMENT OF DNA/PROTEIN MIXTURE AT 280 NM



The measurements taken from other commercial UVC LEDs show significant variability probably due to LED heating and degradation. In contrast, the DNA purity measurements using Crystal IS LEDs are stable and have better accuracy.

The high light output of the Optan LED also allows for a lower detection limit of 0.5 ng/μl for concentration of double stranded DNA (dsDNA) and the excellent spectral quality of the LED leads to linearity of measurement over three orders of magnitude of concentration from 0.5 – 2000 ng/μl.

LINEARITY OF MEASUREMENT





Although broad spectrum xenon flash lamps have better stability than mercury lamps for DNA purity measurements, instruments with these lamps tend to be more expensive.

Xenon flash lamps generate ample light across multiple wavelengths, but only light at a particular wavelength is useful for any single parameter measurement. The remaining unwanted spectra are filtered out to avoid interference. Since DNA purity is determined by absorbance measurements taken specifically at 260 nm and 280 nm, additional elements such as filters and mirrors must be used to filter out unwanted wavelengths before the light reaches the sample.

Xenon flash lamps also require high voltages and increased shielding of electronics during lamp ignition. These expensive electronics coupled with additional optical components quickly adds to the overall cost of the instrument as shown below.

	Xenon Flash Lamp System	UVC LED System
Light Source	\$600	\$600
Power Supply & Trigger Socket*	\$1000	\$50
Excitation Filter for 260 nm	\$350	\$0
Excitation Filter for 280 nm	\$350	\$0
Silicon photodiodes (UV enhanced)	\$100	\$100
Total	\$2400	\$750

**Systems using xenon flash lamps require a trigger socket in addition to the power supply. This is not necessary for LED-based systems.*

Systems using UVC LEDs can match and sometimes exceed the performance of lamp-based systems, while delivering higher efficiency and reduced costs for fixed wavelength applications. This allows the instrument designer to capitalize on the other benefits of UVC LEDs, such as cost and size, without sacrificing quality. These new devices are driving innovations in instrument design for the life sciences to address key market trends around productivity, cost reduction, and miniaturization.

Crystal IS **ADVANTAGE**

LEDs offer light stability, instantaneous response and generate less heat compared to traditional light sources. In addition, Crystal IS deep UV LEDs provide:

- > High spectral quality for measurement linearity over a wide concentration range
- > Small footprint for design freedom and flexibility
- > Single peak and simple drive electronics allows for less costly, application-specific instruments



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