Comparison of an APD and PMT for Far- and Near-UV Measurements

Introduction

There are numerous detectors available obtaining highly sensitive, low noise measurements in the UV and visible regions. While photomultiplier tubes (PMTs) are usually used as the standard detector for UV-Vis instrumentation, there are also semiconductor-based detectors such as PIN photodiodes (PDs) and avalanche PDs (APD).

This article compares the Far- and Near-UV circular dichroism spectra using a PMT and an APD.

Experimental

The following detectors were used: PMT, APD-A (supplier A), and APD-B (supplier B). The detector noises were measured using the air spectrums, (i.e. no sample cell). A 1 nm spectral bandwidth and 1 second digital integration time (D.I.T.) were used for the measurements.

The relationship between noise and absorbance each of the PMT and APD-A were evaluated by measuring 0.63 mg/mL of $KMnO_4$ at 200 and 300 nm. The absorbance was increased by changing the pathlength. A 1 nm spectral bandwidth and 1 second digital integration time (D.I.T.) were used for the measurements.

Results

To view the noise derived only from the detectors, the air spectrums were measured and shown in Figure 1. The noise of the APD-A was less than half of PMT from 180 to 350 nm, while the noise of the APD-B was roughly the same as that of the PMT.

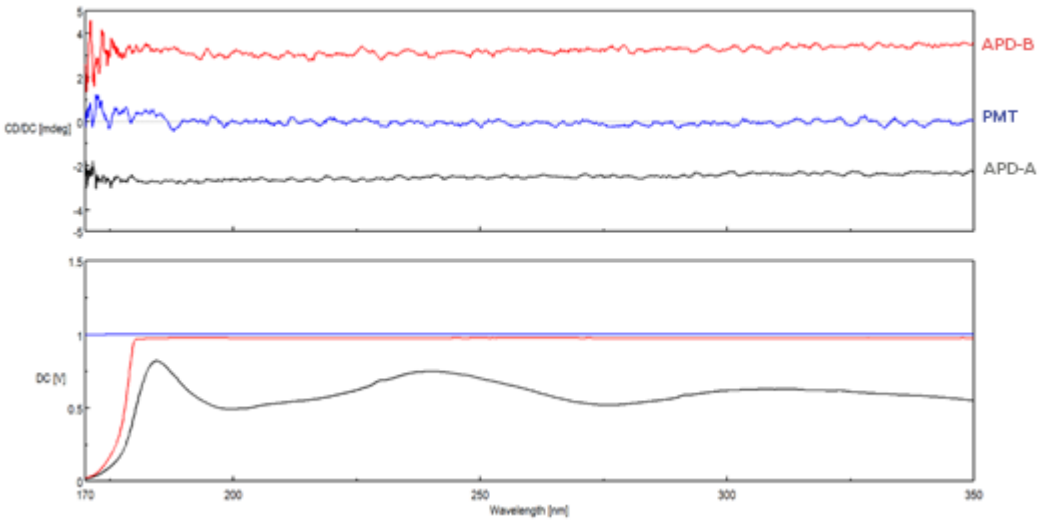

Figure 1 Air spectrums measured by PMT, APD-A, and APD-B.
(Data are offset to show minute changes in the spectra.)

The noise in the CD signal as functions of absorbance at 200 and 300 nm were measured and shown in Figure 2. At both the Far-UV (200 nm) and Near-UV (300 nm) wavelengths, when the sample absorbance was less than 0.3, the noise of APD detector was less than that of the PMT detector. However, at absorbances greater than 0.3, the PMT detector was less noisy than the APD detector. The noise of the APD detector at 0 absorbance units at 300 nm was almost half of the PMT, consistent with the results shown in Figure 1.

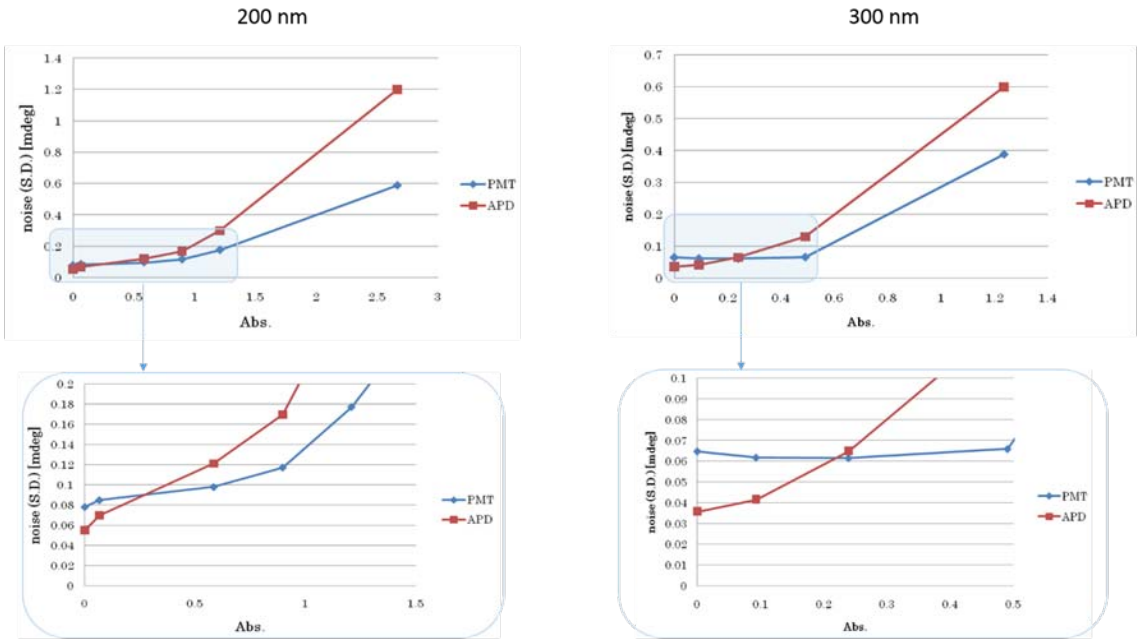

Figure 2 Noise as functions of absorbance at 200 nm (Far-UV) and 300 nm (Near-UV) each of the PMT and APD-A detectors.

Discussion

In this study, the APD detector generated less noise than the PMT detector from 200 to 700 nm at very low absorbance range (0-0.3), while the PMT showed less noise at higher absorbance than 0.3. For many CD applications including protein structural studies, the required sample concentrations commonly yield absorbance values higher than 0.3, making the standard PMT detector a better choice.