

## Fluorescence Detection of Counterfeit US Currency

### Introduction

United States currency is the most counterfeited currency in the world due to its status as a 'hard' currency, similar to gold. Large numbers of bills in all denominations are counterfeited and passed to unsuspecting merchants and banking institutions. In the past, only large denominations like the \$100 and \$50 bill were counterfeited. Currently, however, numerous businesses report the receipt of counterfeit \$5, \$10, and \$20 notes with the \$20 note being passed with the highest frequency. One of the most common types of counterfeit detection is provided by ultraviolet light.

The paper used in the printing of real currency has a high starch content making it appear dull under UV light. Counterfeiters generally use bond paper that has virtually no starch and is bleached. The bleached bond paper fluoresces under UV light. UV detection of counterfeit currency has been in use since approximately 1976, and has been fairly effective. Recently, security thread has been implemented to prevent counterfeiters from passing off a bill as one of a higher denomination. A security thread is a thin thread or ribbon running through a bank note substrate. The thread in the new notes glows when held under an ultraviolet light, which makes it difficult to copy the currency with a commercial color copier. Using a unique thread position for each denomination starting with the \$100 note prevents certain counterfeit techniques, such as bleaching ink off a lower denomination and using the paper to "reprint" the bill as a higher value note.

This application demonstrates how FP-6200 can be used to verify the identity of currency through the presence of security thread and the background fluorescence of the bill. This fluorescence intensity can also be used to study the aging and manufacturing reproducibility of currency.

### Keywords

FP-6200, fluorescence, materials, solid-state, FPA-810



**FP-8500**  
Spectrofluorometer

## Experimental

The FP-6200 fluorescence spectrophotometer equipped with a solid sample holder accessory was used for all analyses, shown in Figure 1. The solid sample holder is kinematically mounted in the instrument sample compartment to provide the proper orientation of the sample to the excitation and emission ports. Bills of denomination \$5, \$10, \$20, \$50, and \$100 were placed in the sample holder such that the security thread was exposed to the excitation beam. Emission scans of both sides of each bill were collected and several locations on the security thread for each bill were also examined. The background fluorescence of the bill was subtracted from each scan of the security thread.

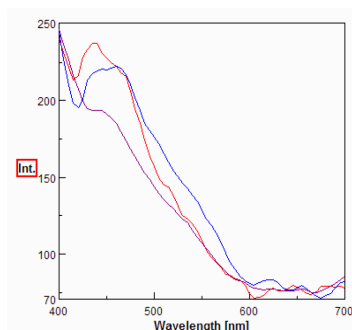


**Figure 1.** Solid sample holder accessory FPA-810 with \$20.00 bill.

Measurement Conditions			
Excitation bandwidth	5 nm	Emission bandwidth	5 nm
Excitation wavelength	365 nm	Emission range	400-600 nm
Data interval	1 nm	Scanning speed	125 nm/min
Temperature Range	15-90°C	Temperature Interval	5°C

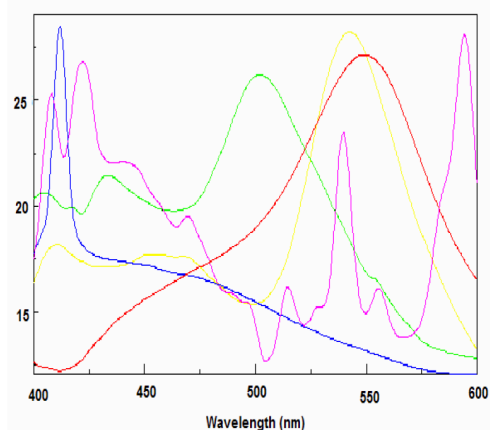
## Results

Figure 2 shows the characteristic background fluorescence of US currency.



**Figure 2.** Fluorescence emission spectra of US (red), Canadian (blue), and Japanese (purple) currencies.

Representative scans of the security threads are shown in Figure 3. The emission bands are wide and distinctly identify each bill. The fluorescence intensity of the security threads appeared to decrease with apparent use and handling of the bills, as newer bills displayed a stronger fluorescence intensity. The fluorescent threads examined in this study did not have a uniform intensity along the length of the thread. This suggests that fluorescence could be used for quality control of the production of these security devices. Table 1 designates the color of the emitted fluorescence of the security threads.



**Figure 3.** Fluorescence spectra of the security threads in a 5 (blue), 10 (red), 20 (green), 50 (yellow), and 100 (pink) dollar bill.

**Table 1.** Emitted color of security threads in US currency.

Denomination	Security Thread Color
5	Blue
10	Red
20	Green
50	Yellow
100	Pink/Orange

## Conclusion

Fluorescence instrumentation can be used to evaluate the authenticity of US currency. The fluorescence intensity of the bill's security thread can be monitored to ensure currency validity and provide a method for the examination of aging of a bill.