Some uses of black plastic 35mm film containers as sample cells

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Introduction

Sample cells for near infrared (NIR) spectrometers are usually designed for a particular instrument and are often quite expensive because of the need for quartz windows and precision moldings. The Rapid Content Analyzer (RCA) module of the Foss XDS NIR spectrometer (Silver Spring, MD, USA) has a large sample chamber with a horizontal sample window. The window is illuminated with a collimated beam of monocromatic radiation which is directed from the exit slit of the grating monochromator by a fibre optic cable. Samples are positioned directly on the window and the diffusely reflected energy is collected by silicon and lead sulphide dectors mounted just below the window. An iris tablet holder is an available option that can be used to hold tablets of different diameters in the centre of the window. With this type of carefully engineer arrangement, the requirement for complex sample holders is not essential and this poster describes the use of a frequently disposed object, the black plastic 35 mm film container (BPFC), as a sample container as shown in Figure 1.

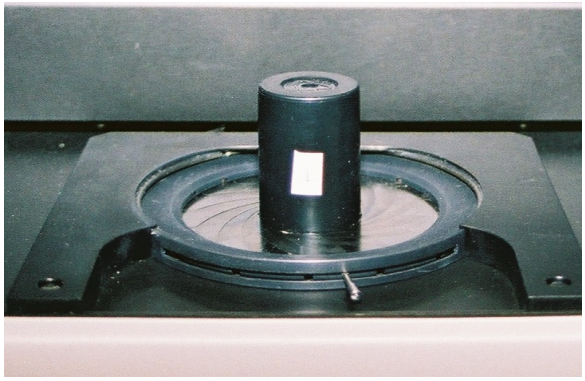

Figure 1. Black plastic film container positioned in a Foss XDS NIR spectrometer.

Applications

So far the PBFC has been used in three different modes and a fourth (untested) use is proposed.

For powder samples

The cell is filled approximately half full with the sample then held in the BPFC by placing a window of kitchen PVC film (known in the UK as "cling film"). As the PVC window is placed in direct contact with the flat RCA window a good optical contact is made from

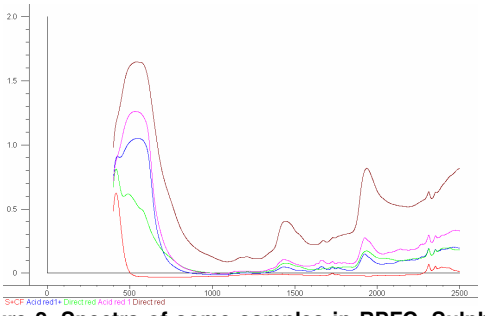

Figure 2. Spectra of some samples in BPFC. Sulphur, Acid Red 1 (15% in S), Direct Red 75 (15% in S), Acid Red 1 (100%), Direct Red 75 (100%).

Near Infrared Spectroscopy: Proceedings of the 11th International Conference.
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widow to sample. Figure 2. show the spectra of some samples of red dyes.

For food material

The idea has been tested for holding samples of banana. Almost any soft, semi-soft or fluid samples that produce a diffuse reflection can be easily sampled. For hard materials a core sample of the appropriate size would extend the possible applications.

For testing the performance of the instruments electronics

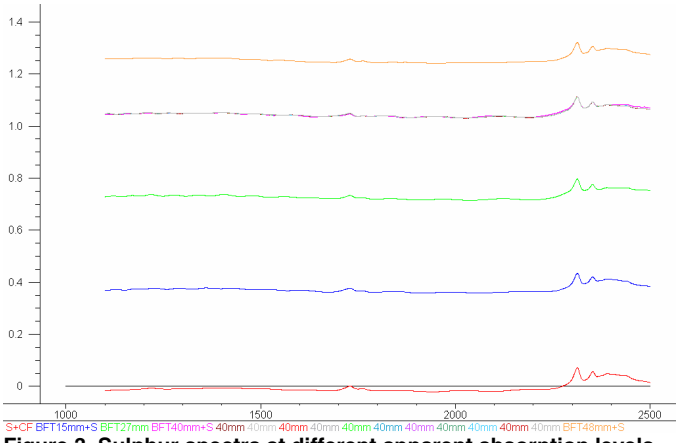

Figure 3. Sulphur spectra at different apparent absorption levels.

Sulphur is a very good reference for NIR measurements and was first utilised by Kronstein et al.[1] It property has been utilised in previous work[2-4]. As seen in Figure 2 a BPFC containing sulphur produces a flat spectrum that is mainly below zero because the sulphur is a better reflector than the reference. The ends of BPFCs were removed so as to leave open cylinders of different length. These were used to place a BPFC containing sulphur at increasing distances from the window of the RCA and their spectra were recorded. The effect of moving the sample away from the window is to reduce the cone angle of energy which can be reflected to the detectors, thus the detectors collect less and less energy and this is recorded as an apparent increase in absorption as shown in Figure 3. This technique cannot be used to test detector responses so it is not a replacement for reflectance standards. Although it might be used to detect differences in the positioning of detectors in different individual XDS spectrometers. However, it can be used to measure the spectrometer's performance to different signal levels. Figure 3. actually contains eleven spectra at the approximately log1/R 1.0 level that could be used to compute a noise value at this absorption level.

Low cost set of reflectance standards

As we have already seen sulphur (S) is a very good, near 100%, reflector of NIR energy. Carbon black (C) is a very efficient absorber of NIR energy. Thus mixtures of C and S can be made to produce flat spectra at all practical levels of absorption. These mixtures could be held in CF sealed BPFCs and easily transported around the world. Their efficient use probably depends on a technique described by Karl Norris[5] when measuring small levels of talc mixed with cellulose. In order to overcome the problem of non-homogeneity the samples were tumbled to mix them and rescanned 20 times. The 20 spectra were then averaged to produce a single spectrum to represent that sample. The same technique could be used to obtain accurate positioning of the spectrum of each sample. A set of five - ten samples would be required to specify an absorption scale which could be used to characterise the absorption scale of any spectrometer that works in the reflectance mode. Such a system is urgently required to enable groups from around the world to pool their data.

Conclusions

BPFCs are a very low cost and a readily available item. Because of their low cost, the BPFC can be used to hold a permanent reference sample of the test material. Although the idea has only been tested in an RCA attached to an XDS spectrometer, it should be noted that a vertically mounted fibre optic probe would be a very convenient alternative, which makes the idea transferable to most currently produced spectrometers.

BPFCs could become part of a universal calibration system for the absorption scale of NIR spectrometers.

References

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