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Rapid Analysis of Textiles with Portable Near Infrared Spectroscopy

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Introduction

Clothing, bedding and cloth toys such as stuffed animals are often made of cotton, polyester, silk and other textile materials. With certain materials being significantly cheaper than others, counterfeiting is rampant, as manufacturers use polyester/cotton blend in place of pure cotton, polyethylene terephthalate (PET) in place of silk, and wool/acrylic fiber blend in place of pure wool. Traditionally, samples are sent to a laboratory for analysis via chromatography or other destructive analytical methods, where pre-treatment of the sample with strong acids such as nitric acid is required. This is both time-consuming and dangerous to the scientist as well as the environment, and is not effective in combating counterfeiting of textiles on the spot.

NIR spectroscopy is a green technology that is non-destructive, efficient, rapid and accurate, with no sample preparation needed. It has been successfully applied in fields such as food, chemicals, tobacco, agricultural products, and pharmaceuticals. When applied to the rapid identification of textiles, it removes the need for strong chemical solvents to dissolve the samples, meaning that there is no destructive sampling, greater safety for the operators, and no hazardous materials output into the environment. In addition, the B&W Tek i-Spec Plus is a portable instrument that can be taken on-site for direct analysis, simplifying the process to combat counterfeit textiles.

i-Spec Plus Portable NIR Spectrometer with BWIQ Chemometric Software

The B&W Tek i-Spec Plus is a complete near infrared system that has a built-in integrating sphere and tablet PC with a touch screen, allowing for full portability. The on-board spectral collection software and an optional external battery pack allow users to conduct on-site testing. The spectrometer may also be connected to an external PC so that users may take advantage of the BWSpec and BWIQ software to collect data and develop applications and perform chemometric analysis for quantitative analysis. The *i-*

Spec Plus has 2 models, one with a spectral range of 900-1700nm with a resolution of 3.5nm, and the other covering the spectral range from 1100-2200nm.

BWIQ is B&W Tek's chemometric analysis software that contains the common pretreatment methods and multiple regression methods including principal component regression (PCR), partial least squares (PLS) and support vector regression (SVR) for non-linear modeling. The software guides users through the building of a model, making what used to be a complex process clear and easy with fast computing and simple variable adjustments.

Experimental

Diffuse reflectance NIR spectra were collected with the *i*-Spec Plus portable NIR spectrometer with a range of 900-1700nm and a resolution of 3.5nm. Scans were taken with an integration time of 1200µs with 32x averaging.

The samples used were blended fabrics of varying cotton and polyester content, with cotton content from 0.031% - 0.856% (percentage by mass) and polyester fiber content from 0.144% to 0.969%. A total of 27 samples were measured, with 3 scans per sample.
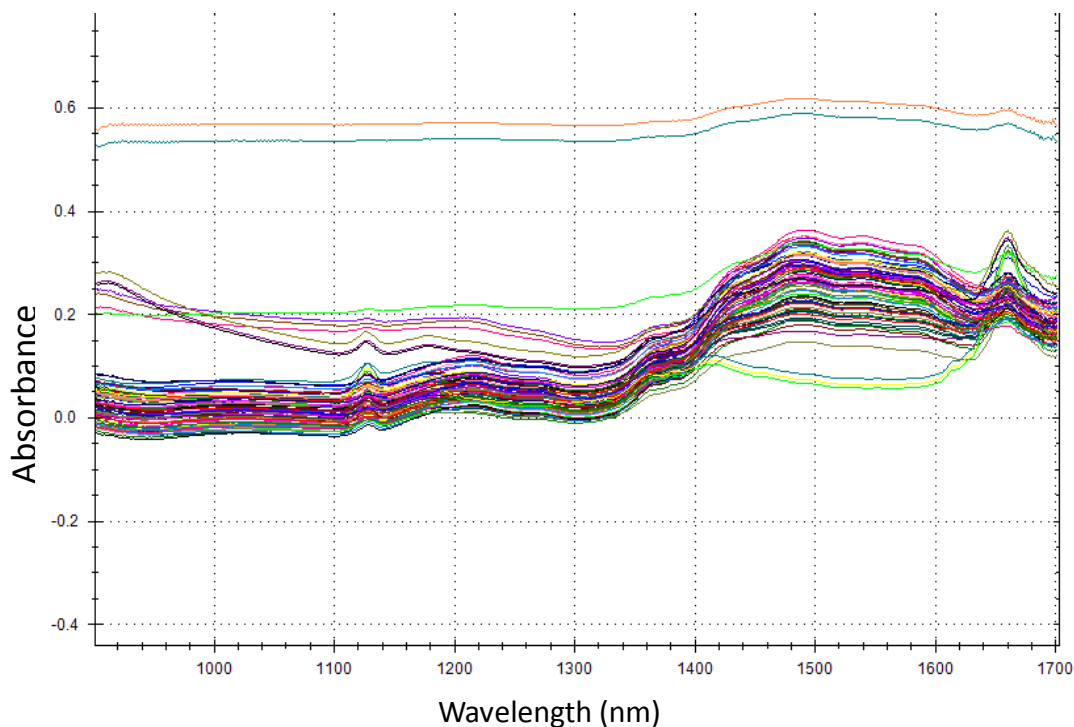

Figure 1. NIR spectra of textiles with different cotton content

Results and Discussion

Gas chromatography-mass spectrometry (GC-MS) was used to confirm cotton and polyester fiber content values of each sample, which was used to create a calibration model in BWIQ using PLS. The data were mean-centered and smoothed using Savitsky-Golay pretreatment.
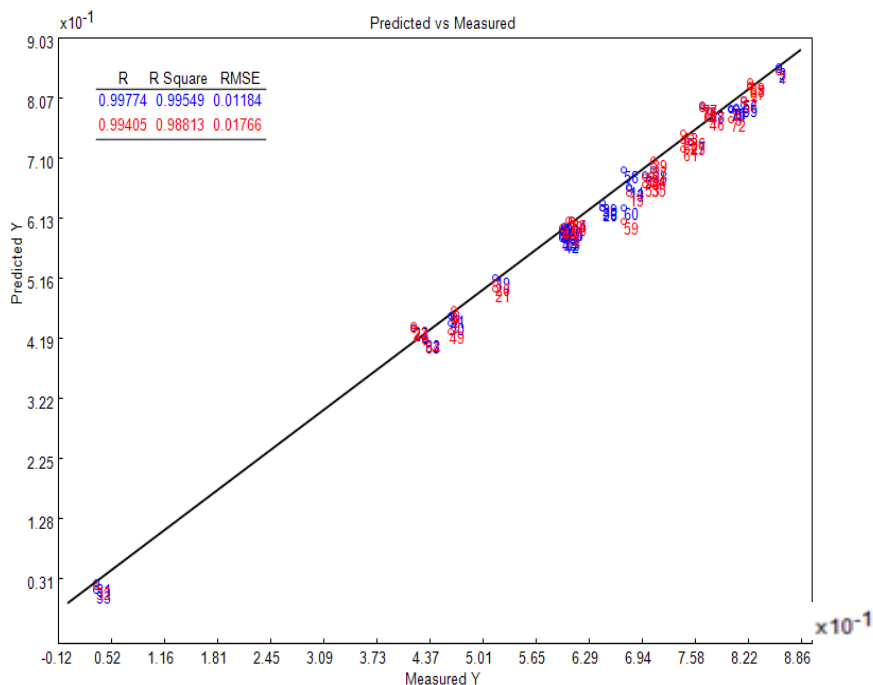

Figure 2. PLS regression of cotton content

The PLS model for the cotton content in the textile has 7 PLS factors and gives a linear fit as can be seen in the 45 degree plot of the predicted compared to measured values. The training set samples are given in blue, and the validation set is in red. As can be seen from Figure 2, the R^2 coefficient is 0.996, while the root mean square error (RMSE) of the training set and validation set were 0.01184 and 0.01766, respectively. From the RMSE for both the training and validation set, we can see that this is a good model that can be used to predict new textile samples.

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Conclusions

The *i*-Spec Plus is ideal for accurate non-destructive quantitative analysis of cotton and polyester fiber content in textiles. The compact design and portability gives users the ability to conduct analysis directly in the field for a variety of industries and applications such as food, textiles and pharmaceuticals.

The unique ability to toggle between the onboard tablet and an external PC on the *i*-Spec Plus gives the unit even more utility. When working on a PC, the user can utilize BWIQ to perform advanced chemometrics and modeling. Meanwhile, on the tablet, users can perform onsite analysis based on the quantitative models to give real-time results for specialized applications. B&W Tek can also support users with further development and technical support based on their application needs.

Additional Resources

i-Spec Plus Datasheet

BWIQ Datasheet

If you have any questions about the application or would like to know how Raman would work for your application, please contact us at appnote@bwtek.com or call us at +1 (855) 297-2626 to speak with an expert.