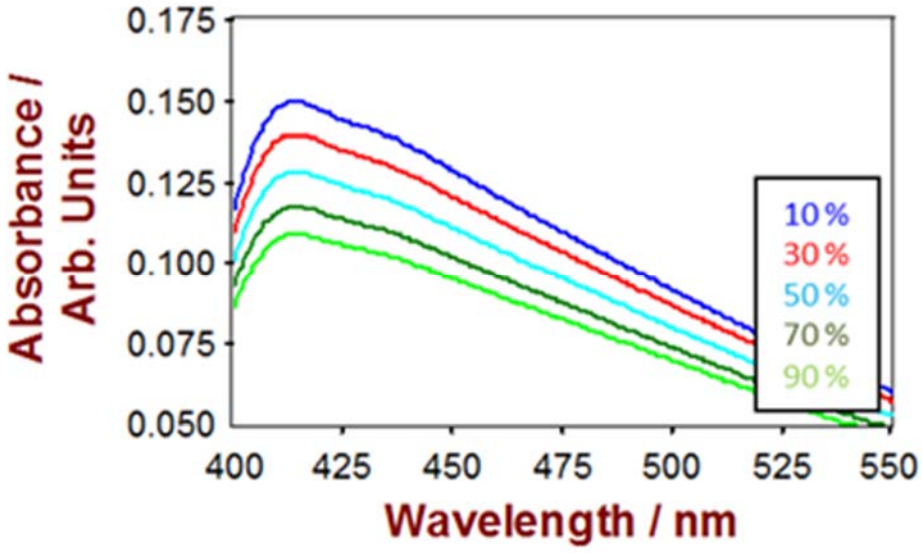
NIR Application Note NIR-32

Determination of cotton linter to wood ratio in cellulose



This Application Note shows that Vis-NIR spectroscopy can be used to determine the cotton linter to wood ratio in cellulose samples. This ratio is important in pulp and paper industry and is commonly achieved with time-consuming lab methods. Vis-NIR spectroscopy offers time saving of analysis.

Metrohm NIRSystems

Method description

Introduction

Wood pulp and cotton linter pulp are the main sources of cellulose. Cellulose is often treated with monochloroacetic acid and sodium hydroxide to form carboxymethyl cellulose (CMC). CMC of low, medium and high viscosity is used in pharmaceutical and chemical industry as a suspending agent. The viscosity of CMC solutions depends on the ratio of wood to linter pulp, where the viscosity for linter pulp is around 8000 cP at 1% and wood pulp around 300 cP at 1%.
Vis-NIR spectroscopy can easily be applied to determine the cotton linter to wood ratio in cellulose samples. The results allow determining the viscosity of the finished CMC product.

Configuration

Tab. 1: Used equipment

Equipment	Metrohm code
NIRS DS2500 Analyzer	2.922.0010
NIRS DS2500 Iris	6.7425.100
Vision 4.03 Software	6.6069.102

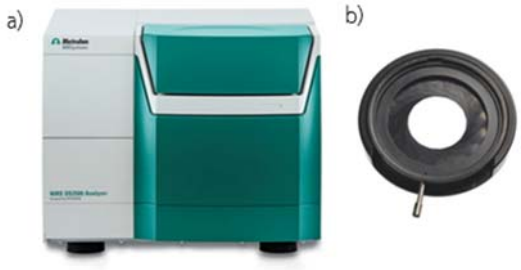


Fig. 1: a) A NIRS DS2500 Analyzer was used to record the spectral data. b) The NIRS iris adapter centered the sample glass vials above the measurement window.

Experimental

A NIRS DS2500 Analyzer (reflection measurement) was used to collect the spectral data of cellulose samples containing different ratio of cotton linter to wood (0 % - 100 %). The samples in glass vials were centered above the measuring window using the NIRS DS2500 iris. The data were collected over the full Vis-NIR wavelength range (400 – 2500 nm).
Vision (Metrohm chemometrical software) with the algorithm of Partial Least Squares (PLS) was used to develop quantitative prediction models for the ratio of cotton linter to wood. The spectral data were pre-treated using a baseline correction at 850 nm. Cross-validation was applied to verify the performance of the derived calibration model.

Results

The spectral data in the visible range displays a good correlation (Fig. 2) between the linter content and the absolute absorbance value. Combination of the NIR region with the visible range provides an excellent model result; see Fig. 3 and Tab. 2.

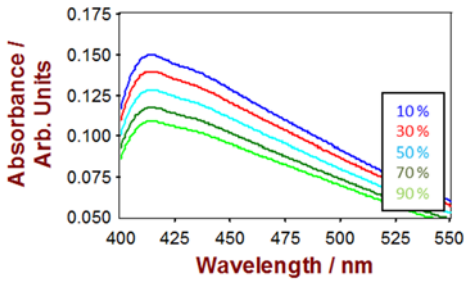


Fig. 2: Spectra of cellulose samples (λ = 400 – 550 nm) with varying linter to wood ratio from 10 % – 90 %. A good correlation in the visible range is observable.

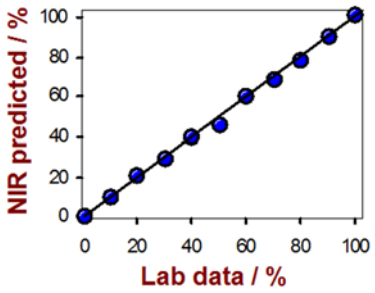


Fig. 3: Correlation of NIR predicted values to lab data for the ratio of cotton linter to wood as a result of quantitative method development.

Tab. 2: Results of the quantitative method development

Regression model	PLS with 3 factors
Pre-treatment	Baseline correction at 850 nm
Wavelength range	420-1080 nm, 1120-2480 nm
R^2	0.9982
SEC	1.6934
SEV	2.3001
SEP	1.5452
F-value	1276.35
PRESS	58.19