

Compact Liquid UV-Scanner for Remote Use

Abstract

The concept for a compact spectrometer setup for remote applications is presented. The setup is tailored for investigations in the UV but also in the visible and near infrared spectral region (200nm – 1000nm). It contains a battery for in-field applications, without the need for an external power supply during operation.

Introduction

Spectroscopy in the UV spectral region is an established method for the quality analysis of liquids, for instance for the detection of impurities in water samples. Impurities are often caused by for instance proteins, chemical and other organic residues and pollutants in waste. The absorbance spectra of solutions of butylparaben in water at low concentrations is shown in *figure 4*. Especially, in the UV spectral region, strong absorbance of this substance allows its detection even at concentrations, as low as 1ppm.

Also, protein trace analysis can be performed in the UV spectral region. Characteristic wavelength is 280nm, where characteristic functional groups of proteins absorb light (refer to course “Lab 8: Quantifying Protein Concentrations” on <https://chem.libretexts.org/>).

In this document, the concept for a remote module is presented for the in-field analysis of water and other liquids.

Problem Statement

Submission of liquid specimen, collected in-field, to laboratories for analysis, is time consuming, prevents immediate adjustment of experiment and/or immediate action.

Technical Solution

A compact and lightweight spectrometer module is presented with on-board power supply (*Figure 1*).

The liquid to be analyzed is filled into a standard (10mm path) cuvette and placed in the module for

measurement of the UV- transmission spectrum, a spectral region for the analysis of protein residues.

The module also allows for transmission spectroscopy in the visible up to the near infrared spectral region for collecting additional spectral information (spectral region from 200nm – 1000nm).

The optical transmission of the investigated samples is measured with a standard optical measurement setup, as displayed in *figure 1*.

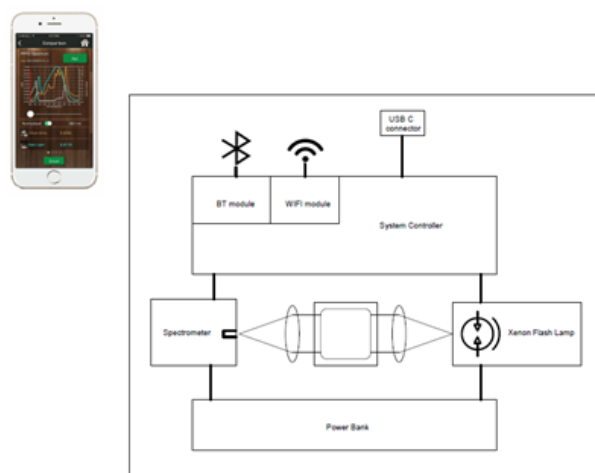


Figure 1: Liquid UV-Scanner: Functional Module.

A suitable pulsed light source (*Figure 2*) is the xenon arc flashlamp Avalight-XE-HP (200-1000nm) of company Avantes BV.



Figure 2: Light source by AVANTES.

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The light pulses are transmitted through the cuvette and analyzed by a compact spectrometer setup. We suggest NEXOS USB spectrometer as seen in *figure 3* (Compact line 2048pixel detector, MN0300-0.30, slit 100 μ m, spectral resolution 4.8nm (FWHM)).



Figure 3: NEXOS USB spectrometer, AVANTES.

The measured spectra are evaluated by an on-board processor and transferred to an APP on a mobile phone via the "Bluetooth" antenna of the module. Additionally, the acquired data can be stored on a USB stick.

The data and results are displayed on the mobile phone and can immediately be considered infield.

The module is equipped with a power-bank, allowing for 4h of continuous measurements or 12h in standby mode.

The overall dimensions of the module are 35x20x10 cm and it weighs less than 2kg.

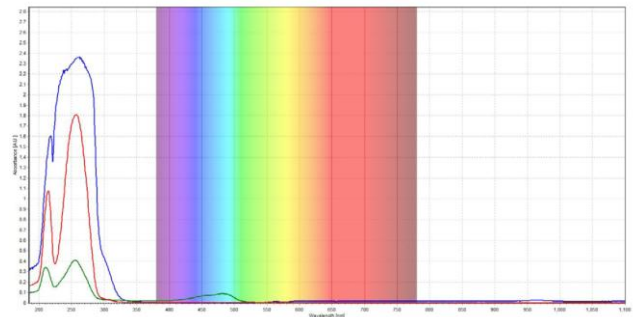


Figure 4: UV/VIS/NIR absorbance spectra of different concentrations of butylparaben solutions (100ppm, 10ppm, and 1ppm) in water. (Reproduced with kind permission from „Application Note – Experiment; Detect low limits of particles in water“, David Ademe, Avantes Inc.).

Conclusion

A concept for a mobile, compact spectroscopy module for remote quality testing of liquid samples has been presented.

The module acquires optical transmission and / or absorbance spectra of liquids in the UV as well as the visible and near infrared spectral region.

Applications are the pollutant and residues analysis of water and other liquid samples.

Typical substances to be detected are proteins as well as organic pollutants, which exhibit strong absorbance in the UV spectral.

The liquids to be examined in the field are placed into the module in standard 10mm cuvettes.

This concept bears sufficient operation time for a day in field due to an on-board rechargeable power source.

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