Far away, but still within reach

UV-VIS measurements with fibre-optics – Successful analyses using routine systems

It is often necessary to monitor the quality of products or raw materials located remotely from the UV-VIS spectrophotometer. Fibre-optics technology makes this possible. In this article the performance of a fibre-optical probe is demonstrated by comparing the transmission measurements of a strongly absorbing solution, successfully achieved with a routine system.

Shimadzu’s UV-1700 is a high-performance, application-oriented and compact spectrophotometer and in combination with the HELLMAN fibre-optical probe and fibre-optic enables fast and precise measurements of UV-VIS spectra. The UV-1700 (190-1100 nm) can be operated as a stand-alone instrument or via the user-friendly UVProbe software. Using the standard SUPRASIL® 300 dip probe and the quartz fibre-optic (monofibre) for the UV-VIS, a spectral range of 220 nm up to 1100 nm is attainable. HELLMAN offers a fibre-optic adapter that can be attached via the standard cuvette holder (Figures 1 and 2) connecting the fibre-optic probe to the UV-1700.

Performance

In order to verify the performance of the system, potassium dichromate (K₂Cr₂O₇) solutions of differing concentrations were examined. As a reference the equivalent spectra of the 10 mm quartz cell measurements were used. The absorption path length of the dip probe used was also 10 mm. Due to the construction of the dip probe, where the light beam is passed through the sample only once, the measuring principle applied is the same as in cuvette measurements. A total of five different concentrated K₂Cr₂O₇ solutions in 0.01 N (0.025 M) H₂SO₄ were used.

The complete UV-VIS spectrum was acquired for each solution and the absorbances at the characteristic wavelengths at A = 260 nm and A₂ = 350 nm were measured. Figure 3 shows a comparison of the spectra obtained for the cuvettes and the dip probe with a 2 m fibre-optic probe for the dichromate measurement.

It is clear that above 270 nm there is very good correspondence between the spectra obtained via both techniques. Only below 270 nm is a decrease in transparency of the fibre-optic observed for the highest concentrations, with a corresponding slight decrease in the signal to noise ratio of the absorption signal. To get a complete overview, the absorbances at 260 nm and 350 nm are shown in Table 1.

Application area

The spectra obtained using the standard dip probe and the 2 m UV-VIS fibre-optic with fibre-optic adapter correspond very well with the 10 mm quartz cuvette measurements over the entire spectral range of 220 nm up to 1100 nm. Shimadzu’s UV-1700 with fibre-optic and dip probe is therefore very well suited for spectroscopic measurements that need to be carried out at a distance from the sample.

This includes measurements of raw materials for manufacturing processes at production site as well as measurements that due to their hazardous nature cannot be carried out directly in the spectrophotometer. Furthermore, measurements in hazardous explosive environments are included, measurements of highly toxic and radioactive compounds as well as measurements in highly contaminated areas.

The fibre-optic system presented here can also be used in unaltered form for the UVmini-1240, MultiSpec-1521, UV-1650PC, UV2401PC and UV2601PC.

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Table 1: Absorbances at 260 nm and 350 nm of the five dichromate solutions of different concentrations.

<table>
<thead>
<tr>
<th>Concentration (mg/L)</th>
<th>Extinction using the fibre-optical immersion probe</th>
<th>Extinction using the 10 mm quartz cuvette</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.278 (0.161)</td>
<td>0.278 (0.157)</td>
</tr>
<tr>
<td>30</td>
<td>0.446 (0.300)</td>
<td>0.401 (0.285)</td>
</tr>
<tr>
<td>60</td>
<td>0.958 (0.644)</td>
<td>0.935 (0.629)</td>
</tr>
<tr>
<td>120</td>
<td>1.744 (1.281)</td>
<td>1.752 (1.296)</td>
</tr>
<tr>
<td>180</td>
<td>3.216 (2.319)</td>
<td>3.244 (2.349)</td>
</tr>
</tbody>
</table>

Figure 3: Comparison of UV-VIS measurements of a K₂Cr₂O₇ solution in 0.01 N (0.005 M) H₂SO₄. 10 mm quartz cuvettes and dip probe measurements are shown together.

Figure 4: Comparison of the 10 mm cuvette- and dip probe measurements at 260 nm (black graph) and at 350 nm (blue graph). Equal wavelengths have the same colour.

The deviations from the cuvette measurement, even at the highest concentrations are less than 2 % (280 nm), and less than 1 % (350 nm).
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