APPLICATION NOTE

AN1001: Low molecular weight polystyrene characterized by SEC-MALS

The fundamental physical principles of light scattering employed in a DAWN® or miniDAWN® multi-angle light scattering (MALS) instrument enable low molecular weight materials to be characterized effectively without the need for column calibration or reference standards. Thanks to their advanced electro-optical design, samples with molecular weights below two thousand Daltons can be measured easily and with remarkable precision.

The DAWN's multi-angle detection system means that accurate molecular weights can be determined—even from samples which produce low signal levels, whether they are ultra-low-concentration high-MW molecules or higher concentrations of low-MW molecules. Since each and every detector contributes to the molecular weight calculation, the result is more sensitive and precise than that produced by any single or dual angle instrument. This is particularly important for low molecular weights where the signal may be only slightly above the background produced by scattering from the solvent.

Figure 1 shows the SEC chromatogram, overlaid with molecular weight values derived from MALS measurements, for three narrow polystyrene samples nominally of 580, 1400 and 2000 g/mol. Corresponding masses injected were 7.1, 2.9 and 2.2 mg, respectively. ASTRA® software determined the following weight-average molecular weights, all very close to the stated MW values.

Samples	Stated MW	Light Scattering MW
A	580	512 ± 17
B	1400	1370 ± 29
B	2000	2012 ± 40

Although the misconception lingers that light scattering is ineffective at low molecular weights, this experiment demonstrates that it can be used to produce robust and accurate results.

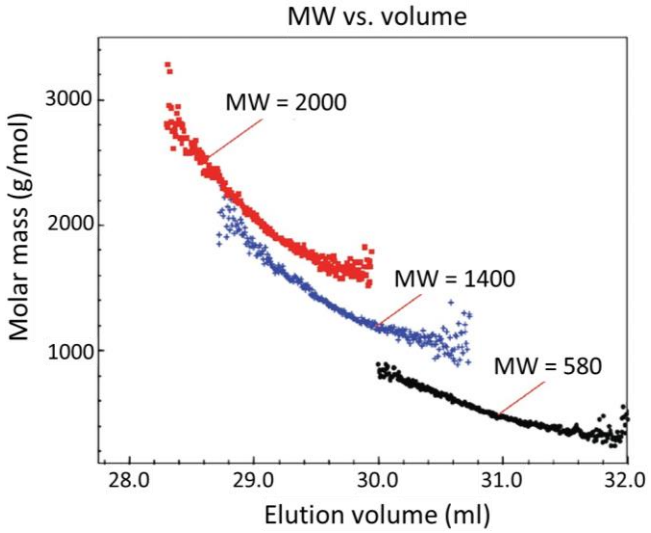


Figure 1. Three narrow polystyrene samples showing the range—into the low molecular weight region—that can be measured accurately by light scattering with excellent signal-to-noise ratio.

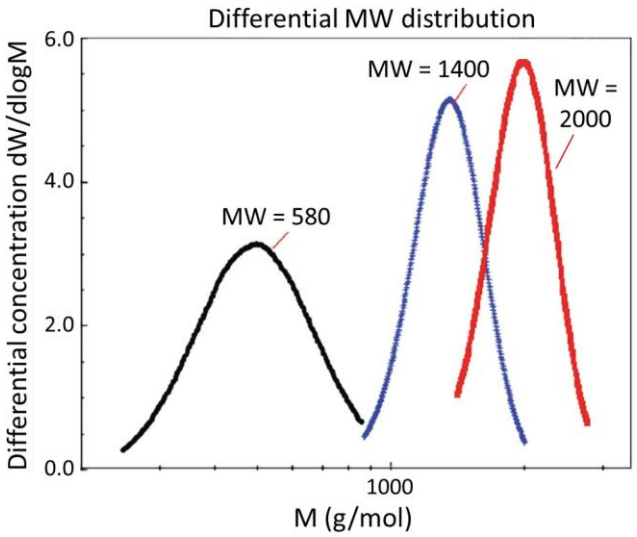
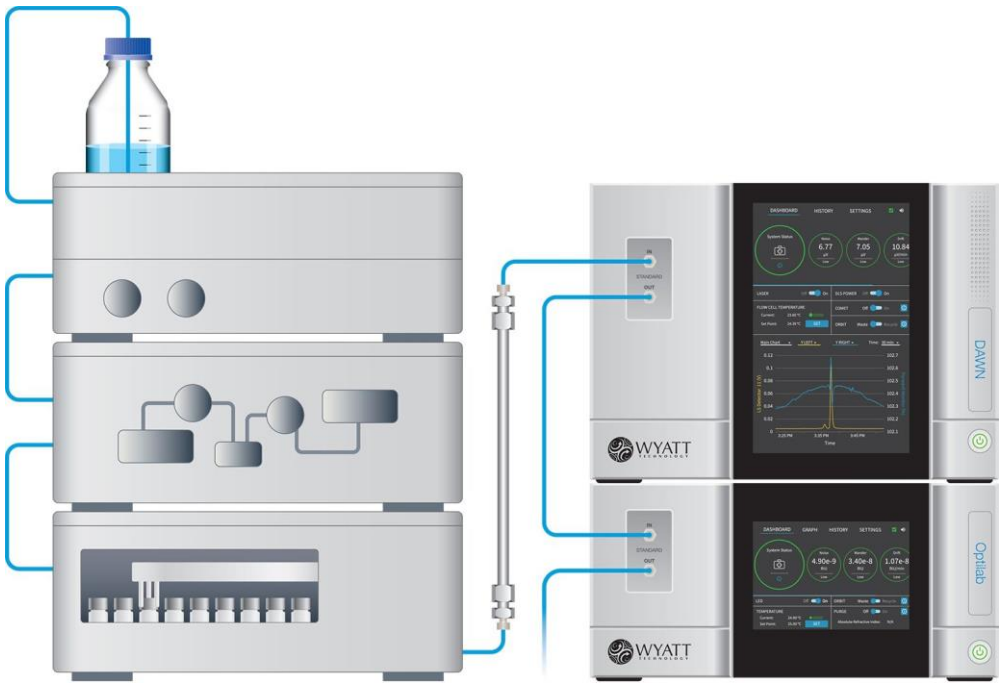


Figure 2. The same three samples' differential molecular weight distributions are robust and reliable—even for "low" molecular weights.

Figure 2 shows the results of ASTRA's differential molecular weight distribution analysis of the three samples. While MALS is widely prescribed in the characterization of molecular weights from 10^4 to 10^9 g/mol, it is not widely recognized that this technique is effective for smaller molecules too. These data clearly indicate that MALS has no difficulty analyzing molecules in the range of hundreds to thousands of g/mol. In fact, reliable measurements have been demonstrated on other samples down to 200 Da!

For light scattering, the lower molecular weight detection is limited only by the concentration of the sample being prepared, as opposed to any inherent measurement shortcomings. This application note confirms that the lower limits can be extended into the range of only a few hundred Daltons—with no column calibration, reference standards, or other assumptions required.



WYATT TECHNOLOGY