

Bottle-Brush Polymers

Bottle-brush polymers are a type of high molecular weight (MW) graft polymers with very dense and regularly-spaced side chains. Brush polymers possess more compact structures (smaller hydrodynamic radius) than their linear analogs at the same MW, and therefore they elute more slowly than their linear analogs at the same MWs in the GPC column. Accordingly, traditional GPC that is based on standard calibration curves cannot give accurate MWs for brush polymers. For complex polymers with non-linear architectures, it is very important to measure the absolute MW using light scattering.

Recently, we have efficiently synthesized various brush polymers with high MW and low polydispersity index (PDI) using ring-opening metathesis polymerization of macromonomers. These brush polymers were characterized using a GPC with a DAWN EOS Multi-Angle Light Scattering (MALS) detector, an Optilab DSP differential refractometer, and a ViscoStar viscometer.

Figure 1 shows MW vs elution volume for a narrowly dispersed polystyrene (PS) brush polymer and a polydisperse PS linear polymer and their chromatographs from the refractometer. It can be clearly seen that at the *same* elution volume, the brush polymer has a higher MW than the linear analog as measured by MALS. Furthermore, the MW does *not* change significantly with elution volume—in contrast to the polydisperse linear PS, thereby indicating its low PDI. The Mark-Houwink-Sakurada plot of these two polymers shows dramatically reduced intrinsic viscosity of the brush polymer compared to the linear analog at the same MW (Figure 2).

This note captures the essence that the three Wyatt-detector system is a powerful tool to characterize polymers with non-linear architectures.

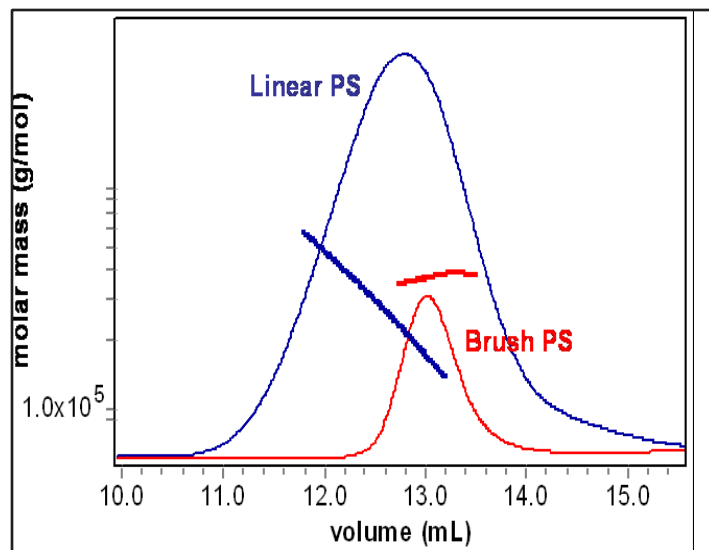


Figure 1. Chromatograms and MW vs elution volume of a polydisperse linear PS and a narrowly dispersed PS brush polymer.

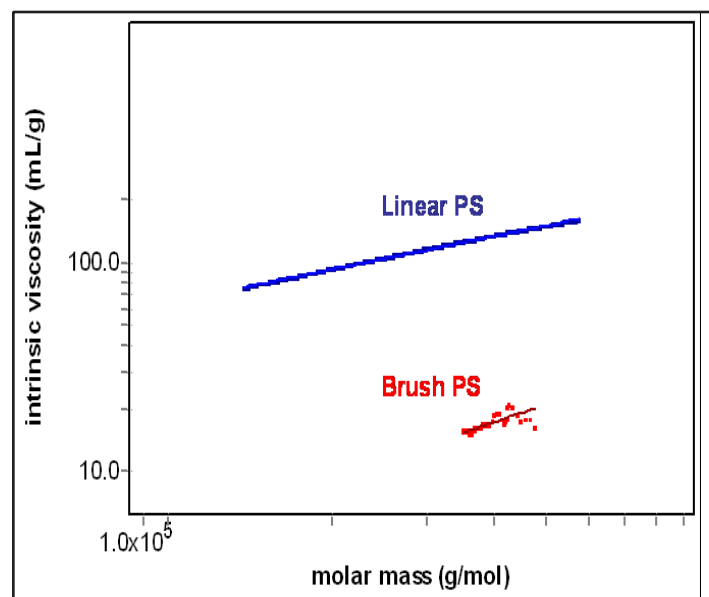
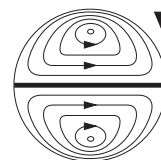


Figure 2. Mark-Houwink-Sakurada plot of a polydisperse linear PS and a narrowly dispersed PS brush polymer.

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