COMPREHENSIVE ANALYSIS OF MACROMOLECULES BY CHROMATOGRAPHIC METHODS

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ABSTRACT

Macromolecules play an important role in almost every aspect of our life spanning from proteins to synthetic polymers. The understanding of structure-property-function relationships is crucial for the design of optimized and sustainable use of macromolecules. This requires comprehensive analytical techniques to characterize various properties from molecular to macroscopic scale. This short course will present an overview of chromatographic methods that are used to characterize complex macromolecules with regard to molar mass distribution, chemical composition distribution, molecular architecture distribution, functionality type distribution. The potential and limitations of individual techniques will be discussed.

The major advantage of chromatography lies in its ability to separate macromolecules and determine the property distributions, which are key to fine-tuned products and applications. Since size-exclusion chromatography (SEC, GPC) is the major tool for macromolecular chromatography, this technique will be covered in more detail. Interaction chromatography (LAC) is an alternative method to SEC, which is strong in the separation of chemically different species, but is poor in investigating molar mass dependence. The combination of both separation techniques (2-dimensional chromatography) overcomes the limitations of each technique, dramatically enhances resolutions and allows to determine chemical heterogeneity and physical polydispersity of copolymers, blends, telechelics, etc.

The combination of a separation technique with intelligent detection like on-line viscometry, light scattering and infrared spectroscopy allows for further in-depth investigation of e.g. physical, compositional, structural aspects in each analytical fraction. Light scattering and on-line viscometry allows to distinguish between branched and linear architectures of the polymer and make structural information accessible. In combination with infrared spectroscopy determination of the chemical composition of a polymer via detection of the presence of characteristic functional groups is possible. Benefits and limitations of hyphenation with mass spectrometry and NMR will also be discussed.

Further reading (review papers):

D. Held, P. Kilz, Characterization of Polymers by Liquid Chromatography, *Macromolecular Symposia*, **231**, 145 (2006); DOI 10.1002/masy.200590019

P. Kilz, Optimization of GPC/SEC Separations, in: HPLC Made to Measure; S. Kromidas (Ed.), Wiley, Weinheim 2006

P. Kilz, Two-Dimensional Chromatography as an Essential Means for Understanding Macromolecular Structure, *Chromatographia* **59**, 3 (2004)

P. Kilz, H. Pasch; Coupled LC Techniques in Molecular Characterization; in: Encyclopedia of Analytical Chemistry (R.A.Meyers, ed.), Vol. 9, pp 7595-7543, Wiley, Chichester 2000