MASTER OF SCIENCES

"ADVANCED SPECTROSCOPY IN CHEMISTRY"

Project case study - 10 ECTS credits
Autumn 2017 (Semester 3)

Title: Quasi-Elastic Light Scattering as a Modern Analytical Tool for Characterization of Nano-Sized Particles in Liquids

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Laboratory:	**Department of Chemistry**
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Topic

The phenomenon of light scattering is familiar to anyone who has entered a dark dusty room in which a beam of light enters from a small hole in a window curtain. Classical static light scattering (SLS) and quasi-elastic dynamic light scattering (DLS) from various submicron sized particles in liquid media arises mainly from concentration fluctuations. In SLS experiments the scattered intensity is averaged over a fairly long time (1-2 s), and thus the time average equals the ensemble average. The concentration fluctuations are often rather fast (in the order of 10^{-6} second). With the aid of modern multipliers these can be followed as a function of time. A proper evaluation using quasi-elastic technique allows studying on the dynamics of individual chains.

To summarise, DLS and SLS allow for studies of

- absolute determination of molar mass
- radius of gyration
- thermodynamic quality of solutions
- diffusion of particles
- dynamics of individual chains in dilute and concentrated solution
- hydrodynamic radius and size distribution
- intermolecular interactions
- internal motion of individual chains
- relaxation processes in gels

Such analytical instruments as liquid chromatography and field-flow fractionation are equipped with SLS and DLS detectors. Zetasizers have become a necessary tool in chemistry, biology and physics. This project provides students with essential theoretical and experimental skills for such data analysis and results interpretation. Students are supervised to prepare particles (synthetic or bio polymers, polymeric or inorganic nano particles) and study their properties in aqueous or organic media.

keywords: light scattering, molar mass, size distribution, diffusion, hydrodynamics, intermolecular interaction

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Project case study - 10 ECTS credits
Autumn 2017 (Semester 3)

Title: Utilization of capillary electrokinetic chromatography for determining hydrophobicities of compounds

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Topic

The hydrophobicity of compounds is commonly described with the octanol-water partition coefficient, which provides information about the physico-chemical properties of compounds. The octanol/water distribution constant and the logarithm of the distribution constant, i.e., log $P_{o/w}$, are the most common parameters used to describe the hydrophobicity or lipophilicity of compounds. These values are also good descriptors for describing the relationship between the structure and biological, pharmacological, and ecological effects of the compounds. However, for charged (ionized) compounds it is important to consider the distribution constant of the ionized compound between n-octanol and a buffer with the target pH value. To get a better understanding of the distribution of compounds between lipophilic and hydrophilic phases, micelle or liposome/aqueous partitioning coefficients, which are dependent on van der Waals and hydrogen donor/acceptor interactions between the compounds and the lipophilic membrane, can be determined.

A number of techniques have been developed to quantify molecular interactions and measure the interactions between drugs and lipid vesicles. Methods applied to interaction studies in the pharmaceutical and biomedical sciences include equilibrium dialysis, ultrafiltration, ultracentrifugation, filtration, calorimetry, microdialysis, spectroscopic, chromatographic, and capillary electrophoresis (CE) based methods. Among the used methods, CE has proven to be an attractive tool because detailed information about the dynamics of molecular interactions under physiological conditions in efficiently separated mixtures with minimal sample consumption can be obtained. Nowadays a common set up for investigating analyte-liposome interactions is liposome electrokinetic chromatography (LEKC). In LEKC the capillary is filled with a background electrolyte solution containing liposomes, which will serve as a dispersed phase (pseudostationary phase). Interactions of the analytes with the liposomes in the BGE affect the electrophoretic mobility of the analytes and this change can be used to show, and even quantify, the interactions in the terms of binding, dissociation, or distribution constants.

In this work the interactions between compounds and pseudostationary phases in EKC will be determined and various micellar and liposome phases will be compared.

keywords: capillary electrophoresis, pseudostationary phase, liposome, hydrophobicity, lipophilicity

MASTER OF SCIENCES

"ADVANCED SPECTROSCOPY IN CHEMISTRY"

Project case study - 10 ECTS credits
Autumn 2017 (Semester 3)

Title: Development of novel carbohydrate-based chemicals and related applications

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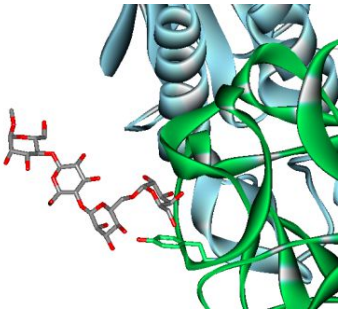
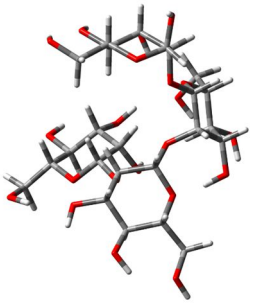
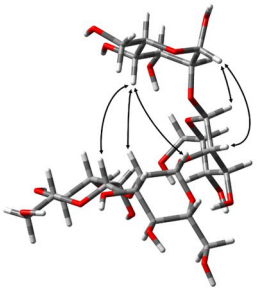
The supply of fossil raw materials, like coal and oil, are limited on earth. When the supply of these materials decline, the use of renewable raw materials or substances produced thereof may be a realistic answer to the challenge of keeping the high standards in society. As a result, utilization of renewable resources must be emphasized in future scientific planning. In Finland, like in any country with a developed forest industry, there is access to forest industry based raw materials e.g. carbohydrates (monosaccharides, disaccharides, oligosaccharides and polysaccharides). In order to make the production of carbohydrates more appealing and economically relevant their incorporation into fine chemicals, building blocks for more complex structures (e.g. pharmaceutical ingredients) and new types of materials must first be sorted out in a delicate way. While being the most abundant group of the renewable resources, carbohydrates also play an essential role in a wide range of biological recognition events and cell-cell communication processes. The wide occurrence of carbohydrates coupled with their biological significance have ensured that studies on the behaviour and applications of these resources are an attractive and important research topic in modern science. Within the scope of this project, the aim is to develop novel carbohydrate based chemicals and construct bioconjugates for advanced studies in the fields of chemistry and biology.







keywords: Biomolecular chemistry, bioconjugates, organic chemistry, structural characterization