



INSTITUTIONEN FÖR KEMI OCH MOLEKYLÄRBIOLOGI

Interrogation of Biological Samples by ToF-SIMS Using New Primary Ion Beams and Sample Preparation Methods

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Abstract

Mass spectrometry is a very versatile and important technique in analytical chemistry. From atomic bombs to Alzheimer's disease, after a century of improvements and developments there are now countless applications for mass spectrometry in research and industry. One important branch within the field is imaging mass spectrometry as it combines chemical and location specific information.

Lipids, the main building blocks of cell membranes, are found in all living, cellular organisms. They are a diverse group of molecules, fulfilling structural and signal transduction functions. Right at the interface between the extra and intracellular environment, they are an important means of fast communication, they build a barrier to keep the cell alive, can promote cell death or indicate cellular changes in general. As different parts of organisms fulfil different functions, so is the distribution of lipids within organisms highly heterogeneous, indicating that each lipid has a role to play at its specific location.

To study the distribution of lipids, imaging time-of-flight secondary ion mass spectrometry (ToF-SIMS) is a well suited technique as it has a high sensitivity for detecting lipids and can detect lipid distributions on a sub-cellular scale in biological samples. As with any technique, ToF-SIMS has some drawbacks, for example it can be highly destructive so analysed lipids are fragmented and the molecular information is lost, there is a trade-off between spatial resolution and molecular information and the signal detected depends highly on the ionisation efficiency of different species, as well as their surroundings, which can skew the results. ToF-SIMS is a vacuum technique which presents challenges for biological sample handling and every analysis is only as good as the sample that is analysed.

To improve upon those aspects, getting more intact molecules at higher resolutions, improving sample preparation, work towards understating matrix effects and study the overall applicability of ToF-SIMS for biological samples was the scope of this thesis.

Keywords

ToF-SIMS, time of flight secondary ion mass spectrometry, imaging mass spectrometry, gas cluster ion beam, GCIB, sample preparation, frozen hydrated, *Tetrahymena*, titanium dioxide, nanoparticles, Irganox, brain analysis, depth profiles, matrix effects, biological samples, lipids, fatty acids, breast cancer, cancer microenvironment