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Evaluation of biomolecules using time-of-flight secondary ion mass spectrometry

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Time-of-flight secondary ion mass spectrometry (ToF-SIMS) provides detailed chemical information including chemical mapping. Its spatial resolution is approximately 100 nm and the analysis depth is less than 2 nm. Therefore, ToF-SIMS is powerful to obtain the distribution of a target biomolecule in tissues and relatively large cells and to evaluate the surface structure of macromolecules. ToF-SIMS has been applied to evaluation of biomolecules in plant and mammal tissues. However, ToF-SIMS raw data contains too much information to interpret by manual analysis. Therefore, multivariate analysis techniques such as PCA and G-SIMS that was developed for interpretation of the secondary ions in ToF-SIMS spectra are often employed to interpret ToF-SIMS data. In terms of the study for biological mechanisms it is crucial to evaluate biomolecules in tissues and cells. In this presentation, biological molecule imaging in plant and mammal tissues by means of ToF-SIMS and data analysis techniques are introduced. Data analysis techniques are useful for finding out important secondary ions showing the distribution of a target molecule. Even the distribution of an extremely low amount biomolecule can be suggested by ToF-SIMS using a huge cluster ion beam such as Ar1000+. Moreover, ToF-SIMS is useful for evaluating surface structures of macromolecules. For example, amyloid beta (1-40) adsorption on lipid membranes was investigated in terms of peptide aggregation changes depending on the physic-chemical properties of a lipid membrane. Amyloid beta on a softer lipid shows homogeneous adsorption while the peptide on a harder lipid shows aggregation. The aggregation difference can be shown from secondary ion images and important secondary ion peaks related to amyloid beta suggested by principal component analysis (PCA). In addition, regarding peptide analysis, it has been indicated that peptide fragmentation would be depending on the energy/atom (E/n) of a primary ion beam. For molecular detection approximately E/n = 3eV/atom is useful and for the detection of peptide fragment ions that are useful for analysing its amino acid sequence E/n larger than 4eV/atom is good. ToF-SIMS measurement by different E/n is essential to identify unknown peptides and to evaluate structures.