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MeV-SIMS with swift heavy ions at low pressure

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Secondary particle emission with swift heavy ion irradiation provides unique opportunities for further insight on ion collision with matter. Those phenomena are utilized in ion beam analysis techniques, and most of the techniques are for elemental analysis. However, strong demand for chemical analysis is growing these days, because of increased importance of organic and biological materials.
We have proposed molecular imaging technique with secondary molecular ions emitted by swift heavy ion beams (MeV-SIMS) for biological material analysis [1, 2]. In this technique, molecular ion emission from organic or biological molecules is utilized for chemical analysis. In conventional SIMS with keV-energy ion beams, elastic collisions occur between projectiles and atoms in constituent molecules. The collisions break the molecules and produce fragment ions, which makes acquisition of molecular information difficult. In contrast, MeV-energy ion beams excite electrons and enhance the ionization of high-mass molecules, which provide chemical information of molecules. Moreover, swift heavy ions produce secondary molecular ions at much higher yields than monomer ions with energy of a few tens keV.
A molecular imaging system combing with orthogonal acceleration time of flight (oa-ToF) mass spectrometer and electrostatic quadrupole focused lens has be developed to analyse biological samples with high lateral (<5 um) and high mass resolution(>10,000). The molecular distribution of small bio-molecules (up to 1 kDa) was clearly imaged with a lateral resolution of around 5 um, opening a new opportunity in organic and biological material analysis.
Furthermore, high energy ion beams (>MeV) have high transmission capability in matter and allows us to use this beam in low vacuum pressure (1,000 Pa) to analyse volatile sample, such as liquids, waters and wet biological samples. Mixture of fatty acid with various vapour pressure was measured, and accurate composition of the mixture was only measured at the vacuum pressure of 500 Pa.

Recent progress in this technique will be presented and discussed along with its possible applications for biological material analysis.

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