Application of MeV SIMS for organic material analysis

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MeV SIMS represents a variation of the conventional Time-of-Flight Secondary Ion Mass Spectrometry (TOF SIMS) technique in which ion desorption is achieved using primary ions accelerated at energies of about MeV/amu. The distinguishing feature of MeV SIMS is the significant influence of electronic stopping, which is more pronounced than nuclear stopping in this energy range. The excitation energy introduced by MeV ions is transferred to the host atoms via electron-phonon interactions, leading to the formation of a cylindrical high-temperature region along the trajectory of the ion. In the high-density infratrack region of the ion track, electron sputtering of inorganic materials and fragmentation of organic materials occurs. On the other hand, intact molecular ions are emitted from the lower energy density ultratrack region, where the coupling between the excitation energy and the internal vibrational modes of the organic molecules is weak. Consequently, MeV SIMS provides a higher yield of secondary molecular ions with less fragmentation compared to conventional SIMS, which uses keV ions.

Coupled to the microbeam chamber where focused ion beams are used, this property makes MeV SIMS particularly suitable for chemical imaging of organic molecules with a mass of up to 2000 Da. This capability is especially valuable in the analysis of complex organic materials, including recyclable materials such as polymers, bioplastics, and composite materials. By providing detailed molecular insights with minimal fragmentation, MeV SIMS facilitates the identification of chemical compositions, degradation mechanisms, and potential contaminants in recyclable materials. This makes it a powerful tool for enhancing material recovery processes and improving the quality control of recycled products.

In this presentation, the application of MeV SIMS in the analysis of organic samples will be demonstrated across diverse fields such as biology, forensics, and cultural heritage. Special attention will be given to its potential in characterizing organic recyclable materials, showcasing its value in sustainable material management and circular economy practices.