FAST HEAVY ION INDUCED DESORPTION OF BIOMOLECULES:

APPLICATIONS AND MECHANISTIC STUDIES

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ABSTRACT

The mass spectrometry application of fast heavy ion induced desorption (FHIID) and the results of a mechanistic study of this phenomenon using scanning force microscopy are presented as the two main works in this thesis. Previous works on the mechanistic studies of FHIID and on plasma desorption mass spectrometry (PDMS), an application of FHIID, are reviewed in order to provide a background for the experimental works included in this thesis.

A description of major research activities in PDMS in Colombo, performed during the course of my post-graduate studies, is presented. A description of the first plasma desorption mass spectrometer in Sri Lanka, with an emphasis on the mass resolution and ion yields obtained, is given. The construction of a new straight-mode plasma desorption mass spectrometer with the capability of bombarding the sample by primary ions both from the front and from the back side of the sample is briefly described. Such a feature greatly enhances the variety of types of samples which can be analysed.

An analysis of the plasma desorption mass spectra of nine low molecular weight (190 u - 430 u) natural product compounds, previously chemically isolated in Sri Lanka, is also presented. The observed positive and negative quasi molecular ion peaks, fragment ion peaks and adduct ion peaks in the mass spectra are discussed with respect to the molecular structure of the compounds in both positive and negative ion modes. Plasma desorption mass spectra of five compounds are compared with the corresponding electron impact (EI) mass spectra.

A study of ^{252}Cf fission fragment induced luminescence in the wavelength range 200 - 680 nm from CsI and biomolecules is presented. The observed luminescence is in the near-UV region within narrow time profiles in the nanosecond regime. No correlation between the luminescence and secondary ion emission is observed with the compounds studied indicating that the photon emission is from the bulk. The use of such narrow photon signals as start time markers for time-of-flight measurements (TOF) in ^{252}Cf-PDMS has been demonstrated.

A scanning force microscopy (SFM) study of radiation damage features on mica due to incident fast heavy ions is presented. The damage features were observed to be topological hillocks rather than regions of altered density or friction, as observed by others. The observed properties of the damage features are discussed briefly within the framework of existing theoretical models suggested for FHIID. The variation with ion angle-of-incidence of the damage parameters is presented. First SFM results are also presented from a study of radiation damage features on mica and single-crystals of L-valine induced by fast C_{60} (fullerene) cluster ions. The observed damage features provide more evidence about a radial expansion around the ion track, as predicted by theoretical models. Fast-heavy-ion-induced latent (subsurface) damage tracks on mica observed for the first time by tapping mode SFM are also presented.