Development of a new Scanning UV-Laser Microprobe for Ion Imaging and Confocal Microscopy

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The technical design of a new reflectron time-of-flight laser microprobe mass spectrometer (LAMMA 2000), developed in our laboratory, is described. Instrumental features are fast ion imaging and optical sample imaging with lateral resolution of ≈0.5 µm. Sample illumination, sample observation, laser irradiation, confocal sample imaging and ion extraction are all performed coaxially through a high-numerical UV-transmitting 5-lens objective equipped with a central bore. A diode-pumped Nd:YLF laser has been frequency-quadrupled to 262 nm and is used for both, laser desorption ionization and sample irradiation for confocal scanning microscopy. Advantages of this type of laser are its small physical dimensions and the opportunity to run at high repetition rates of up to 10 kHz, which is a prerequisite for fast imaging.

Sample positioning is performed by a stepper motor driven x-y-z stage. Scanning of an area of 100 x 100 µm is done by a high-speed x-y-z piezo stage. For UV confocal scanning microscopy the same quadrupled Nd:YLF laser is used, running at low pulse energy and high repetition rate. As a result of this optical design scanned areas in the optical confocal imaging mode and in the ion imaging mode are exactly identical, allowing high resolution optical control of mass spectral data acquisition.

Data aquisition for optical and ion imaging as well as instrument control is software driven by a Windows-based software package. Acquired mass spectra of each sample pixel are either stored individually or are processed directly to form a set of two-dimensional ion images. A transient recorder board for PC allows an aquisition rate of more than 50 spectra per second. In the optical imaging mode x/y position and photomultiplier signal are acquired by a high-speed 12-bit A/D converter to build up a confocal image of 400 x 400 pixels within 20 seconds. In addition to that an on-line video camera image is displayed on the PC screen using a PC overlay board combined with frame grabbing functionality to save on-line pictures to hard disk.

First applications of the new instrument are presented in another paper on this conference.

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