3D Micro PIXE – a new technique for microbeam applications

Andreas-Germanos Karydas [(α)], Dimosthenis Sokaras[(α)], Natasa Grlj[(b)], Primoz Pelicon[(b)], Matjaz Žitnik[(b)], Roman Schütz[(c)], Wolfgang Malzer[(c)] and Birgit Kanngießer[(c)]

[(a)]Institute of Nuclear Physics, NCSR "Demokritos", Athens, Greece
[(b)]Jožef Stefan Institute, Ljubljana, Slovenia,
[(c)]Institute of Optics and Atomic Physics, Technical University of Berlin, Berlin, Germany

A novel experimental technique, 3D Micro- Particle Induced X-ray Emission (PIXE) is described in the present paper. 3D Micro-PIXE is realized by using an X-ray optic in front of the detector, thus creating a confocal arrangement together with the focused proton micro-beam. This confocal setup defines a probing volume from which information on elemental distribution is obtained. If a sample is moved through the probing volume, depth resolved measurements become possible with a resolution in the micrometer regime. This development was motivated by the corresponding successful implementation of two X-ray lenses in a typical X-ray Fluorescence (XRF) set-up [1-2]. For the experimental realization of this technique, the nuclear microprobe of the Jožef Stefan Institute was used [3] in order to establish, characterize and apply the confocal setup for 3D Micro PIXE for the first time.

The experimental setup was characterized with respect to its spatial and depth resolution. The 3D Micro PIXE measurements confirmed the potential of the technique to resolve elemental distribution in separate layers in a complex structure overcoming the depth analytical limitations of standard ion beam techniques. As an application example of this new non-destructive analytical technique, an archaeological ceramic fragment exhibited a black gloss layer (of about 20 μm thickness) onto a porous ceramic body was analyzed and a first approach to simulate the complex experimental results is presented. The potential of 3D Micro-PIXE to provide advanced qualitative information on the elemental distribution in the sample is discussed and compared with the 3D Micro-XRF.

1. B. Kanngießer, W. Malzer, I. Reiche, Nucl. Instr. and Meth. B, 2003, 211/2, 259.
2. B. Kanngießer, W. Malzer, A. Fuentes Rodriguez, I. Reiche, Spectrochimica Acta B, 2005, B 60, 41.
3. P. Pelicon, J. Simčič, M. Jakšić, Z. Medunić, F. Naab and F.D. McDaniel, Nucl. Instr. and Meth. B, 2005, 231, 53