



ELSEVIER

Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Nuclear Instruments and Methods in Physics Research B 210 (2003) 123–128

NIM B
 Beam Interactions
 with Materials & Atoms

www.elsevier.com/locate/nimb

Ion photon emission microscopy

P. Rossi ^{a,b,*}, B.L. Doyle ^a, J.C. Banks ^a, A. Battistella ^c, G. Gennaro ^d,
 F.D. McDaniel ^{a,c}, M. Mellon ^f, E. Vittone ^g, G. Vizkelethy ^a, N.D. Wing ^a

^a Sandia National Laboratories, Org. 1111, P.O. Box 5800, Albuquerque, NM 87185-1056, USA

^b Department of Physics of the University and INFN, via Marzolo 8, 35131 Padova, Italy

^c Laboratori Nazionali Legnaro, INFN, 35020 Legnaro (PD), Italy

^d Azienda Ospedaliera and INFN, 35100 Padova, Italy

^e University of North Texas, P.O. Box 311427 Denton, TX 76203, USA

^f Quantar Technology Inc., Santa Cruz, CA 95060, USA

^g Department of Experimental Physics of the University and INFN, 10125 Turin, Italy

Abstract

A new ion-induced emission microscopy has been invented and demonstrated, which is called ion photon emission microscopy (IPEM). It employs a low current, broad ion beam impinging on a sample, previously coated or simply covered with a few microns of a fast, highly efficient phosphor layer. The light produced at the single ion impact point is collected with an optical microscope and projected at high magnification onto a single photon position sensitive detector (PSD). This allows maps of the ion strike effects to be produced, effectively removing the need for a microbeam. Irradiation in air and even the use of alpha particle sources with no accelerator are possible. Potential applications include ion beam induced charge collection studies of semiconducting and insulating materials, single event upset studies on microchips and even biological cells in radiobiological effectiveness experiments. We describe the IPEM setup, including a 60× OM-40 microscope with a 1.5 mm hole for the beam transmission and a Quantar PSD with 60 μm pixel. Bicon plastic scintillator blades of 10 μm were chosen as a phosphor for their nanosecond time resolution, homogeneity, utility and commercial availability. The results given in this paper are for a prototype IPEM system. They indicate a resolution of ~12 μm, the presence of a spatial halo and a He-ion efficiency of ~20%. This marks the first time that nuclear microscopy has been performed with a radioactive source.

© 2003 Elsevier B.V. All rights reserved.

PACS: 61.85.JH; 85.30.TV; 61.16.YC; 78.60.Hk

Keywords: Nuclear emission microscopy; Ion photon emission microscopy; Ion beam analysis

1. Introduction

Nuclear emission microscopies (NEMs) were proposed a few years ago as an alternate way to perform localized single-ion nuclear analysis [1,2], whenever ion beams are difficult or even impossible to focus or when cost issues are important. NEM consists of (1) irradiating a sample with a

* Corresponding author. Address: Sandia National Laboratories, Org. 1111, P.O. Box 5800, Albuquerque, NM 87185-1056, USA. Tel.: +1-505-844-7302; fax: +1-505-844-7775.

E-mail address: prossi@sandia.gov (P. Rossi).