Available online at www.sciencedirect.com
ScienceDirect
Nuclear Instruments and Methods in Physics Research B 266 (2008) 2306–2310
NIM B
Beam Interactions with Materials & Atoms
www.elsevier.com/locate/nimb

The ionoluminescence apparatus at the LABEC external microbeam facility

S. Calusi [a,b], E. Colombo [a,b], L. Giuntini [c,*], A. Lo Giudice [b], C. Manfredotti [a,b], M. Massi [c], G. Pratesi [d], E. Vittone [a,b]

[a] INFN Sezione di Torino, Via P.Giuria 1, 10125 Torino, Italy
[b] Dipartimento di Fisica Sperimentale and NIS Excellence Centre, Università di Torino, Via P. Giuria 1, 10125 Torino, Italy
[c] Dipartimento di Fisica, Università and INFN Sezione di Firenze, Via Sansone 1, 50019, Sesto Fiorentino, Firenze, Italy
[d] Dipartimento di Scienze della Terra and Museo di Storia Naturale, Università di Firenze, Via G. La Pira 4, 50121 Firenze, Italy

Available online 18 March 2008

Abstract

In this paper, we describe the main features of the ionoluminescence (IL) apparatus recently installed at the external scanning microbeam facility of the 3 MV Tandetron accelerator of the INFN LABEC Laboratory in Firenze. The peculiarity of this IL set-up resides in the fact that the light produced by the ion irradiation of the specimen is collected by a bifurcated optical fiber, so that photons are shunted both to a CCD spectrometer, working in the 200–900 nm wavelength range, and to a photomultiplier (PMT). The accurate focusing of the optical system allows high photon collection efficiency and this results in rapid acquisition of luminescence spectra with low ion currents on luminescent materials; simultaneously, luminescence maps with a spatial resolution of 10 μm can be acquired through the synchronization of PMT photon detection with the position of the scanning focused ion beam. An optical filter with a narrow passband facing the photomultiplier allows chromatic selectivity of the luminescence centres.

The IL apparatus is synergistically integrated into the existing set-up for ion beam analyses (IBA). The upgraded system permits simultaneous IL and PIXE/PIGE/BS measurements. With our integrated system, we have been studying raw lapis lazuli samples of different known origins and precious lapis lazuli artworks of the Collezione Medicea of Museum of Natural History, University of Firenze, aiming at characterising their composition and provenance.

PACS: 78.60.Hk; 78.70.En; 07.78.+s; 07.79.−v

Keywords: PIXE; Ionoluminescence; Lapis lazuli; External microbeam

1. Introduction

The analysis of the luminescence induced by MeV ions (IL or IBIL) has attracted considerable interest from the IBA community in recent years, see for example [1,2]. This is mainly due to the potential of this technique to provide information on chemical state of some elements and, hence, to provide complementary information to those obtained with more traditional IBA techniques, e.g. PIXE, PIGE and BS [3]. In addition, the availability of optical spectrographic/spectrometric systems at relatively low cost, which can be integrated in IBA set-ups and are suitable to be synchronized with raster scanning focused ion beams for micro-spectrometric analyses [4–6], makes this technique even more attractive.

A CCD/spectrograph combination allows IL measurements in a wide spectral range at a lower dose with respect to that required using scanning monochromator-based systems. This results in reduced ion damage effects, which in some applications can seriously alter the IL response [7]. Moreover, installation of an IL apparatus in an external beam set-up allows non-invasive analysis of large and/or fragile samples, as art objects.

* Corresponding author. Tel.: +39 055 4572630; fax: +39 055 4572641.
E-mail address: giuntini@fi.infn.it (L. Giuntini).

0168-583X/$ - see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.nimb.2008.03.077