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Recent developments of ion beam induced luminescence at the external scanning microbeam facility of the LABEC laboratory in Florence

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Abstract

A new ionoluminescence (IL) apparatus has been successfully installed at the external scanning microbeam facility of the 3 MV Tandetron accelerator of the INFN LABEC in Firenze; the apparatus for photon detection has been fully integrated in the existing ion beam analysis (IBA) set-up, for the simultaneous acquisition of IL and PIXE/PIGE/BS spectra and maps.

The potential of the new set-up is illustrated in this paper by some results extracted by the analysis of art objects and advanced semiconductor materials. In particular, the adequacy of the new IBA set-up in the field of cultural heritage is pointed out by the coupled PIXE/IL micro-analysis of a lapis lazuli stone; concerning applications in material science, IL spectra from a N doped diamond sample were acquired and compared with CL analyses to evaluate the relevant sensitivities and the effect of ion damage.

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1. Introduction

Ionoluminescence is the name given to photon emission in the IR/VIS/UV range from a material after it has been excited by an ion beam. As such, the response of the excited material is relevant to de-excitation phenomena involving atomic outer energy levels and hence, IL is sensitive to local surroundings of emitting centres and can provide information on material structure and activator impurity content.

If MeV ion beams are used, IL can hardly provide quantitative data, owing the numerous radiative recombination mechanisms involved in the photon emission process induced by MeV ion bombardment and the degradation with ion fluence due to the generation of non-radiative recombination centres. However, IL coupling with other IBA techniques, like PIXE/PIGE (particle induced X-ray/γ-ray emission) and BS (backscattering spectroscopy), provides chemical and structural information to complement elemental analyses [1]. This synergistic combination has triggered the interest of IBA community fatherly stimulated by the pioneer work of Lund and Melbourne groups [2], which first installed IL set-ups at IBA nuclear microprobe facilities correlating elements spatial distribution with maps of luminescence centres. IL was successfully used to characterise a wide variety of advanced materials, minerals, stones and historical/art objects [3–5]. In particular, the increasing interest in the application of IL to

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