Measurement of Ion-impact X-ray Emission by a novel technique based on High-pressure Gas Ampoules in Silicon Blisters

C. Olivares, G. Aníbal, G. Ruano, P. Pérez, F. Divi, E. Sánchez, R. O. Barrachina

Department of Interaction of Radiation with Matter
Bariloche Atomic Centre
National Atomic Energy Commission
ARGENTINA

Measuring X-ray production cross sections of noble gases by proton impact is always a challenge, due to the low intensity of photons produced in a low-density environment. Our proposal is to avoid this disadvantage by employing a novel technique which measures these cross sections on highly stable high-density-pressure gas ampoules implanted in the crystalline structure of Si. These blisters are covered by thin layers of a few nm of Si, which prove to be very stable, even decades after their manufacturing date. The atoms can be contained in gaseous form with pressures estimated in values as high as 3 GPa. By irradiating these samples with protons, an x-ray signal can be measured with a SDD detector. This means that under these conditions the blisters can be used as a thin sample for x-ray production cross section measurement, provided that their gas density is known. To obtain a good estimation for this quantity, the samples are analysed with different techniques, namely, RBS, XPS and AFM. Finally, using a Tandem Ion Accelerator, K-shell x-ray productions cross section is measured from characteristic line yields produced by proton impact with energies ranging from 0.2 to 3.4 MeV. The results obtained in this work might be the first stage in developing a reliable method for the measurement of cross sections in noble gases (Ar, Kr, Xe, …). Furthermore, we proposed to extend the analysis to different substrates, as graphite, to carry out the cross-section measurement in the best conditions available, i.e., with the optimal blister size, pressure and substrate that produces the least interference during the X-ray detection. It should be noted that the resulting cross sections should be equivalent to low-density gaseous target measurements because, even in high-pressure ampoules with densities typical of a solid, the confined gas is only a few nanometres thick, so that the single collision condition remains valid.