Laboratory of Analysis by Nuclear Reactions (LARN): past, present and future activities

Ion beam technologies are powerful tools being used for both the modification (Ion Beam Modification of Materials) and the characterisation (Ion Beam Analysis) of thin films. They are now mature techniques whose development has accelerated in the 21st century, spurred by the critical need for new functional materials. IBA is of central importance for decades in many materials research fields including functional (nano)materials, microelectronics, photovoltaics, batteries, cultural heritage… among many others. IBA is a collection of analytical techniques which has had recent significant advances that have substantially increased its power. The most striking facts are:

- the establishment of RBS as a primary direct reference method for the best traceable accuracy (~1%) available for non-destructive model-free methods in thin films (i.e., High Accuracy IBA);
- the development of powerful software enabling for effectively combining the information available from the atomic and nuclear methods (i.e., Total-IBA);
- the demonstration that robust information can be extracted from IBA spectra even with poor counting statistics.

The LARN has a long history in ion beam technologies, currently basing its research on the use of a 2 MV Tandem accelerator (ALTAÏS). Recently appointed professor at LARN, my ambition is to make these formidable tools available to numerous research programmes through collaboration with researchers who are experts in their own field.

I will show how we intend to breathe new life into Prof. Guy Demortier's pioneering work, by developing our brand new µ-probe for analysing cultural heritage artefacts at atmospheric pressure. Of course, we do not want to limit this equipment to this field, and we also have plan to develop research in life science, geology, or palaeontology.

High Accuracy IBA is another topic close to my heart, and we are currently developing our versatile IBA chamber to precisely control all the experimental parameters, which is required to obtain RBS measurements at 1% absolute accuracy. This is important to produce certified reference materials (CRM) needed by other analytical tools (e.g., ToF-SIMS or XRF) or more fundamental works (e.g., X-ray Fundamental Parameters Initiative). CRMs that we can produce using low-energy ion implantation (<40 keV) thanks to the adaptation of our accelerator's injector to accommodate small samples (i.e., typically 2 cm^2).

The development of a low-background workstation over the last few years has also been proved very useful for PIGE ore RNRA analyses. In particular, the $^{1}H(^{15}N,ag)^{12}C$ RNRA has recently caught our attention since it seems very promising for µ-electronics applications. We also hope to extend these applications to other fields in the future.

Finally, we intend to enable high-throughput analysis by automating both data acquisition and data processing. Using machine learning tools to handle the huge datasets generated by µ-IBA is unavoidable, but applying such tools to a broad-beam analysis would also enable new capabilities such as dynamic studies of thin films evolution under low-energy ion irradiation.

All of these topics will be briefly reviewed in this presentation to give you a flavour of our past, present and future activities at LARN.