RBS Investigations of Layered Targets for SIS18 Beam Loss Collimators ◇

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Since two years an UHV Elastic Recoil Detection Analysis (ERDA) set-up is available at the high charge state injector (HLI) of GSI and mainly used for desorption studies [1]. ERDA with high Z beams starting from Xe up to Au is especially suited for the investigation of light element desorption by heavy ion beams from metallic surfaces. To measure heavy metal coatings, for example, Rutherford backscattering spectrometry (RBS) is more appropriate being the complementary ion beam analysis technique to ERDA. It has a high sensitivity to heavy elements and uses hydrogen or helium ion with a few MeV, typically. Sensitivity and depth resolution, however, are increased with little heavier projectiles such as C which can be frequently used in parasitic mode during the cancer therapy. Typically three month per year the HLI of GSI is exclusively used to produce a 1.4 MeV/u C^{2+} beam. Therefore, we have established heavy ion RBS at the UHV set-up and extended our analysis capability.

Copper coated with 50 - 100 nm gold may be used for the new SIS18 beam loss collimators. Clean metallic copper turned out to have a comparable low desorption yield as long as no oxide layer has grown on the surface. To prevent copper from oxidation it will be cleaned in vacuum and *in-situ* terminated with a thin gold layer. After coating the copper can be exposed to air and mounted inside SIS18. Like each UHV device the collimator has to be bakeable up to 300° C. RBS was used to measure the long term behavior and stability of the gold layer during a typical UHV bake-out cycle.

Results of recent RBS investigations on gold coated copper are shown in Fig. 1. The x-axis shows the scattered projectile ion energy which corresponds to the depth distribution of different elements. Since copper and gold have a quite different mass they are well separated in the energy spectrum (a). The dotted and the dashed-dotted line represent the energy of a projectile ion scattered at a copper and a gold atom, respectively, on the sample surface. From this energy distribution the film thickness can be derived using, e.g., the simulation code SIMNRA [2]. In spectrum (a) one can clearly see the gold layer of 200 nm thickness on top of the copper and no copper on the surface. Spectra (b) to (d) are now different snapshots of the sample during the 300^0 C heating cycle: in (b) the copper starts to diffuse into the gold towards the surface. In (c) copper is diffused into the gold layer to the sample surface and the gold starts to diffuse into the copper bulk. In (d) –the sample was now at 300^0 C for about 100 h– the gold is almost completely inside of the copper substrate.

To avoid this in-diffusion of the gold overlayer work is in progress to find a suitable diffusion barrier and to test the stability of the gold layer during repeated heating cycles by RBS, and by additional ERDA measurements its desorption behavior.

The new heavy ion RBS capability was also used for the characterization of thin film coatings, like NEG getters. Here we are able to measure the stoichiometry of the getter components and the film thickness. Up to now the stoichiometry of the NEG was measured at CERN using XPS and the thickness using SEM. Now both can be determined with high accuracy using RBS and complemented by ERDA where the pumping properties for light elements can be seen.

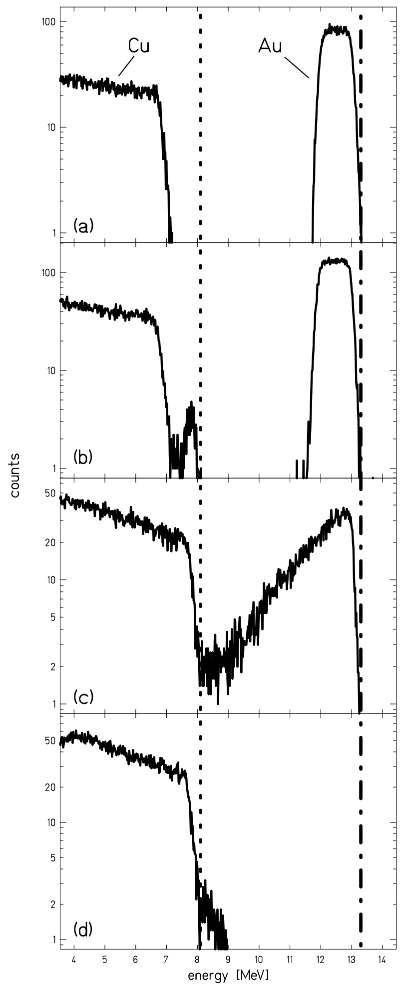

Fig. 1: RBS measurements of copper with 200 nm gold coating using 16.8 MeV ^{12}C ions and a scattering angle of 170 degrees: (a) as prepared, (b) - (c) after heating at 300^0 C for different times (see text).

References

[1] H. Kollmus *et al.*, Annual report 2005, p. 62

[2] M. Mayer, Report IPP 9/113, Max-Planck-Institut für Plasmaphysik, Garching, Germany (1997)

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