Advanced characterisation of nanometer multilayers: depth profiling comparison of RBS, SIMS, XPS and GDOES

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The use of nanometre metal and/or metal compound multilayer coatings is extensively spread in a wide range of applications (i.e. hard protective coatings for mechanical parts and tools, optical coatings for lenses and architecture glass panels, barrier contacts for microelectronics, biomedical prosthesis, etc.). In these and other applications, sharp interfaces and a low degree of mixing between the component materials are strictly required. Obviously, the attainment of these complex structures needs of high resolution analytical techniques to get information about surface and depth composition at nanometric level.

In this work, the range of application of complementary analysis of nanometre multilayer coatings applying Rutherford backscattering spectrometry (RBS), Secondary Ion Mass Spectroscopy (SIMS), X-ray Photoelectron Spectroscopy (XPS) and Glow Discharge Optical Emission Spectroscopy (GDOES) techniques will be discussed. Each of the techniques has several pros and cons: RBS is a non-destructive technique that requires no standard for quantification although the access to large ion-source facilities is needed. SIMS keeps nanometre resolution values at larger depths with excellent lateral resolution, but at the expenses of large experimental times. XPS either using angle resolved measurements or simultaneous ion bombardment provides the depth profile together with chemical information although such information can be modified by the ion bombardment process. Finally, GDOES allows depth profiling in a fast and accurate way, even though depth resolution degrades linearly with depth due to the sputtering crater shape.

In particular, we have compared the depth profiling performance of the different techniques to the case of Cr/Ti multilayer structures with individual thickness ranging from hundreds to a few nanometres. Ultra thin chromium layers of 2.5 and 5 nm, buried at different depths in a titanium matrix up to a thickness of 3 μm, were properly resolved both near the surface and deeply embedded in the matrix and used to evaluate the depth resolution of the techniques.

Keywords: (choose 2 to 4 relevant keywords to be included in the index)

Multilayer coating, depth profiling, surface analysis techniques

Topic: Thin Films