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Surface Analysis of Materials by Elastic Scattering of MeV Ions

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A wide range of surface analysis techniques has been developed, involving e.g. ion, electron and photon beams interacting with a solid target. The techniques are, generally, complementary and provide target information for depths near the surface. Nuclear techniques, which are non-destructive, provide for analysis over a few microns close to the surface giving absolute values of concentrations of isotopes and elements. Their main applications have been given in areas such as scientific, technologic, industry, arts, archaeology and medicine, using MeV ion beams [1-7]. Tracing of isotopes with high sensitivities is possible by nuclear reactions. We use elastic scattering of light low energy ions and the energy analysis method. At a suitably chosen energy of the incident ion beam, an energy spectrum is acquired of ions from elastic scattering events, coming from several depths in the target. Such spectra are computer simulated and compared to experimental data, giving target composition and concentration profile information [4-7]. Elastic scattering is a particular and important case of nuclear reactions. A computer program has been developed in this context, mainly for flat targets [4-6]. The non-flat target situation arises as an extension.
Elastic scattering of α particles was used for analysis. The simulations used published nuclear data, namely for stopping power. Rutherford differential cross section was used. Very good computed fits were obtained to spectral data obtained for two main targets. T1 was a flat target consisting of a thin film of Ag deposited onto a thick Al flat substrate (Al/Ag). An Ag film of very good uniformity, with an estimated thickness of 0.1714 μm, was expected. Analysis was made through a $(^4He)^+$ ion beam at E_α=2.9 MeV and Θ_L=165°, giving an Ag film with excellent uniformity and thickness X_1=0.1610 μm, close to the expectation. T2 was a thick flat target of zinc sulphide (ZnS). Uniform distributions of Zn and S were expected in the target substrate. It was analysed through a $(^4He)^+$ ion beam at E_α=3.1 MeV and Θ_L=165°. Uniform concentration profiles were used with X_1 parameters of 2.5 and 1.5 μm for Zn and S, respectively. Elastic scattering, as a nuclear technique, has shown to be a powerful non-destructive surface analysis analytical tool.

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