# Quantitative High-resolution Depth Profiling Of Light And Heavy Elements With Low-energy High-resolution ERDA

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## ABSTRACT

Ion beam modification and ion beam analysis techniques have had a central role in the CMOS development over the last decades, and for instance Rutherford Backscattering Spectrometry (RBS) is still extensively used by the research institutes and industry. The main reason for this is clear: It can provide quantitative information on the elemental distributions in the sample with a modest, typically 10–20 nm, depth resolution. New materials, devices and structures have, however, sizes near atomic dimensions and here, in many cases, the performance of the traditional RBS does not meet the requirements of the community. However, the detector development in the form of a high resolution magnetic spectrometer [1] and especially a toroidal electrostatic analyzer [2] for Medium Energy Ion Scattering has brought the depth resolution of the backscattering techniques to the sub-nm range.

New possibilities open if, instead of using light ions like H and He, heavy incident ions are used and recoiled sample atoms are detected at the forward direction. With element or mass dispersive energy detector telescope Elastic Recoil Detection Analysis (ERDA) becomes a very powerful tool for materials characterization. In principle all elements, including hydrogen, can be separated and depth profiled by measuring time of flight and energy for each recoil atom in coincidence. If gas ionization detector with thin $Si_3N_4$ window [3] is used for energy detection, the good mass resolution will remain even if low energy incident ions are used. As an example in Fig. 1 TOF-E histogram and elemental depth profiles of 8.6 nm thick atomic layer deposited $Al_2O_3$ film on silicon are shown.

This paper summarizes the latest developments in the low-energy high-resolution ERDA and demonstrates the high performance of the technique via high-k, low-k, and light element shallow implantation analysis examples.

*Keywords: TOF-ERDA, high resolution depth profiling*

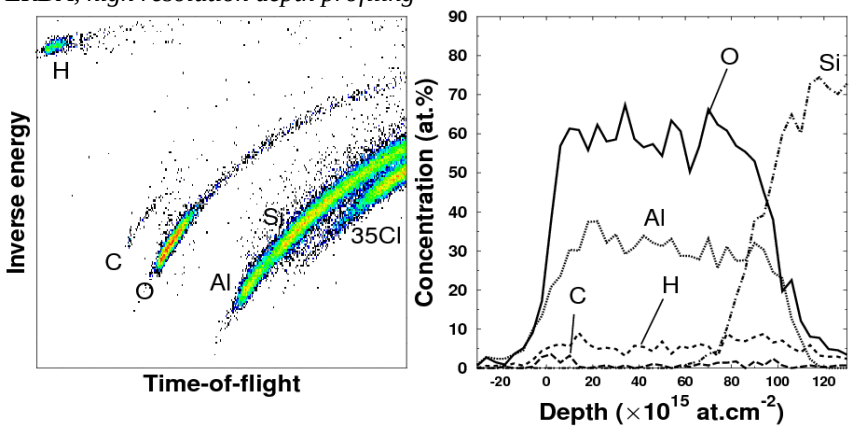


**FIGURE 1.** A raw TOF-E histogram (left) and corresponding elemental depth profiles (right) from an 8.6 nm thick ALD $A_2O_3$ film on silicon measured with 3 MeV $^{35}Cl^{1+}$ beam from 1.7 MV Pelletron accelerator. In the measurement, gas ionization detector was used as an energy detector.

## REFERENCES

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