

# Difference between bulk and thin film densities of metal oxide and fluoride films studied by NRA depth profiling techniques

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## Abstract

Nuclear reaction analysis techniques have been used to study the difference between bulk and thin film densities of different dielectric ( $\text{WO}_3$ ,  $\text{MgF}_2$ ,  $\text{NdF}_3$ ,  $\text{LaF}_3$  and  $\text{ThF}_4$ ) thin films. Thicknesses of the films were measured by optical methods. The  $^{18}\text{O}(p,\alpha)^{15}\text{N}$  reaction was used at 730 keV to profile  $\text{WO}_3$  prepared with different thicknesses on a tantalum backing by thermal evaporation of natural  $\text{WO}_3$ . We have also successfully tested the  $^{18}\text{O}(p,\alpha)^{15}\text{N}$  reaction at the 629 keV ( $\Gamma = 2.1$  keV) resonance for the same purpose. Excitation function measurements of the reaction was performed around the resonant energy at a detection angle of  $150^\circ$ . In order to obtain the oxygen profiles of the thin films non-resonant part of the excitation function was deconvoluted using the known cross-section data of the reaction. Also, we studied different films of  $\text{MgF}_2$ ,  $\text{NdF}_3$ ,  $\text{LaF}_3$  and  $\text{ThF}_4$  using the 483.85 keV resonance in the  $^{19}\text{F}(p,\alpha\gamma)^{16}\text{O}$  reaction.

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