Measurement and theoretical investigation of differential cross sections of elastically backscattered protons from ^{nat}O in the energy range E= 4-6 MeV

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Oxygen is a highly reactive non-metal and thus, it can easily form compounds with other elements and penetrate or diffuse deeply inside several matrices. Therefore, the accurate determination of oxygen depth profiles in various samples is of paramount importance, especially in the semiconductor industry or, e.g., in biological, geological, cultural heritage materials and superconductors. For this purpose, Ion Beam Analysis (IBA) techniques have proven to be very effective, and more specifically, the proton elastic backscattering spectroscopy (EBS) one, which is currently widely used for the detection of almost all the light elements up to a depth of several microns, while d-NRA and ToF-ERDA are usually employed at smaller depths. For the implementation of EBS, evaluated differential cross sections are required, provided by the online R-matrix SigmaCalc 2.0 calculator (http://sigmacalc.iate.obninsk.ru/). In the particular case of oxygen, the current evaluated data for protons cover the energy range between 100 and 4080 keV. However, the ultimate goal to investigate oxygen concentrations at even greater depths, according to the current technological demands, is currently impeded by the lack of experimental and, consequently, evaluated data at higher proton beam energies.

In this study we present the experimental differential cross sections of $^{nat}O(p,p_0)$ elastic scattering, determined via the relative measurement technique, in the proton beam energy range E_{lab}=4-6 MeV with a varying step (from 5-15 keV), at four backscattering detector angles between 140^o and 170^o (with a 10^o step). A thin, self-supporting target manufactured *in situ* was used in this experiment and the determination of its stoichiometry was carried out according to the currently existing evaluation, which has also been benchmarked recently. The measurements were performed using the Van de Graaff Tandem 5.5 MV Accelerator of N.C.S.R. "Demokritos" in Athens, Greece.

Finally, R-matrix calculations for the theoretical investigation of the data have been performed using the publicly available AZURE code (useful in nuclear astrophysics as well) and the obtained results seem to accurately reproduce the current evaluation, along with the differential cross-section datasets obtained in the present work and already existing ones in literature for this extended proton beam energy range. The observed peculiarities and discrepancies, along with the current needs for validation via accurate benchmarking experiments are discussed and analyzed.