determination of hydrogen isotope layer profiles in carbon and beryllium by using electron spectroscopy methods [[1]](#footnote-1)\*)

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In this paper, a quantitative method is developed for retrieving profiles of hydrogen isotopes in beryllium and carbon from elastically reflected electron spectra and reflected electron spectra.

Elastic Peak Electron Spectroscopy (EPES) is a technique for analyzing the hydrogen isotope content in structural materials, often referred to as Rutherford Back Scattering (RBS) recalling the well-known surface analysis method based on light ion scattering [1]. Spectroscopy of elastically reflected electron peaks is implemented with high energy resolution, so that the peaks corresponding to different chemical elements can be resolved according to the Rayleigh criterion. The target probing depth is determined by the inelastic mean free path, i.e. the average electron path length between two inelastic collisions – lin [1,2]. The value of lin increases with the probing beam energy E0 as lin ⁓ E00.8. Hence, by varying the probing energy and corresponding probing depth, the average amount of hydrogen across a layer of the thickness ⁓ lin can be determined, and so, the hydrogen profile can be retrieved. The probing depth is about several nanometers, while the probing energy E0 is of about several keV.

Hydrogen isotope retrieval at depths of the order of the transport length ltr can be performed by means of reflected electron spectroscopy (RES) [3]. Let us note that ltr ≈ 700 nm for electrons with initial energy E0 = 5 keV probing a beryllium target, while at E0 = 30 keV, the corresponding value of ltr is about 15 μm. Thus, RES makes it possible to determine hydrogen at depths varying from several hundreds of nm to several tens of μm (which is much larger than the probing depth of EPES). However, RES is sensitive only to the nuclei charge number and hence is not able to distinguish different isotopes of hydrogen (in contrast to EPES).

Essentially, interpretation of the experimental results of EPES and RES is a complex procedure. In order to determine the intensities of elastically reflected electron peaks from the measures EPES spectrum, it is necessary to perform a non-trivial procedure of subtracting the background component, which is due to inelastically scattered electrons. In order to compute these intensities theoretically, the multiple scattering processes of electrons should be taken into account. Finally, by matching computed and measured intensities, the concentration of a certain chemical element in a multicomponent material can be retrieved. To determine the hydrogen concentration in beryllium or carbon by means of RES, a set of spectra with different layer-by-layer hydrogen profiles is computed. Then, the fitting is performed in a short computation time.

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References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Pt/ru/GM-Afanas%27ev.docx) [↑](#footnote-ref-1)