Quantitative Analysis of the Hydrogen Concentration on Surfaces using SNMS

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The quantitative characterization of the concentration profile of hydrogen H in technical materials still represents a challenge for analytics and, on the other hand, is of great importance for hydrogen technology, especially with regard to the influence that hydrogen has on the material properties. In particular, the reliable detection of relatively small concentrations, in the range of one atomic percent and below, is difficult and requires the use of suitable measurement methods. This is not only due to the fact that hydrogen is also present as a reactive species in the vacuum of the measuring apparatus and provides a background contribution to the actual measurement signal for the hydrogen intrinsically present in the sample. Hydrogen is not directly detectable for the electron spectroscopic methods of surface analysis and also Secondary Neutral Mass Spectrometry SNMS has the problem that the sensitivity factor for hydrogen, with its high ionization energy of over 15 eV, is very small due to the small electron impact ionization cross section. When using quadrupole mass filters, the so-called zero blast occurs as a further problem, which even more hampers the sensitive and reliable measurement of hydrogen concentration depth profiles. Therefore, for the detection and quantitation of hydrogen with SNMS, deviating from the usual quantitation routine, the dimer neutral particle signal I_{MH} is used instead of the atomic one. This molecule is also emitted during sputtering of the sample surface by co-emission of a matrix atom M together with an adjacent hydrogen atom H. Our measurements show that the relative detection factors are then significantly higher. The basics of a quantitation routine with the MH dimer signal is presented, sensitivity factors and detection limits for the measurement of hydrogen with this method are determined and the application of the method is demonstrated using various sample systems from practice.