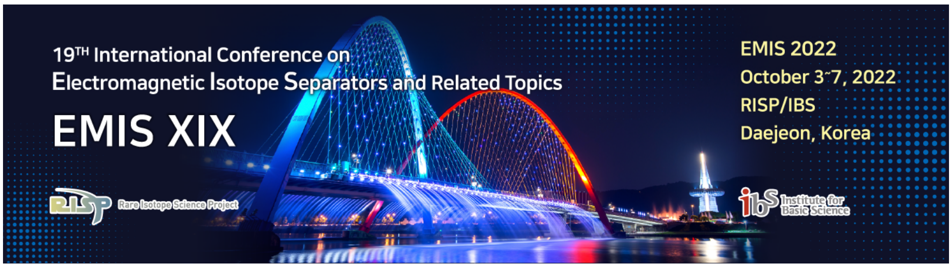

Contribution ID: **45** Type: **Poster Session**

Muonic X-ray Spectroscopy on Implanted Targets

Tuesday, 4 October 2022 22:48 (8 minutes)

Muonic X-ray Spectroscopy is a technique that utilizes the properties of the muon to gain information about the structure of the atom and the nucleus. When interacting with an atom, the muon can be captured in a high principal atomic quantum number state. Once this occurs, it rapidly decays through the muonic energy levels to the atomic ground state, emitting high-energy X-rays (up to 10 MeV). This decay radiation can subsequently be used to identify the muonic energy levels, which reveal information about nuclear properties, such as the nuclear electric quadrupole moment through the hyperfine interaction [1] or the nuclear charge radius from finite size corrections [2].
Since 2017, the muX collaboration at the Paul Scherrer Institute in Switzerland has used a high-pressure hydrogen cell with a small deuterium admixture to improve the muon capture efficiency, allowing for the measurement of target quantities as small as 5 µg [2]. Furthermore, a measurement performed in 2018 showed that about 27% of the muons are transmitted through a 100 nm layer of graphite. This result indicates the possibility of muonic X-ray spectroscopy on implanted targets. Such targets would provide a protective layer to chemically reactive samples that could be manipulated, or allow to apply mass separation combined with implantation to produce isotopically pure samples.

In the 2022 muX campaign at the πE1 beamline at PSI, glassy carbon (SIGRADUR K) samples, each implanted with Au-197 at different energies, will be measured. Thus, the depth dependence of the muon capture efficiency can be investigated. To guarantee swift measurements while optimizing the method, samples are being prepared with a mass about an order of magnitude larger than the minimal requirements. However, this corresponds to particle fluences in the order of $10^{17} cm^{-2}$, which is reaching the self-sputter limit. TRIDYN simulations [3, 4] suggest an unusual behavior of self-sputtering during implantation showing a fast drop in implanted fluence after a maximum is reached, instead of a saturation behavior at maximum capacity. Rutherford backscattering measurements of the different targets is thus performed to validate the TRIDYN simulations.

In this contribution, we shall report on the Au implantation in glassy carbon, from simulation and experimental point of view, as well as present preliminary results from the 2022 muX campaign and the implications for future muonic X-ray measurements with implanted radioactive samples.

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[4] Möller, W. (2014). TRI3DYN–Collisional computer simulation of the dynamic evolution of 3-dimensional nanostructures under ion irradiation. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 322, 23-33.

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