Contribution ID: **81** Type: **Invited Oral**

Ultra-low work function surfaces for H^-/D^- ion sources

Thursday, 11 September 2025 14:10 (30 minutes)

The efficient and reliable production of negative ions is a key challenge for all H^-/D^- ion sources. The method with the highest production rate of H^-/D^- relies on the surface conversion of atomic and positively charged hydrogen/deuterium particles at a low work function (WF) surface. The state-of-the-art to obtain the low WF is by evaporating Cs, the element with the lowest WF (1.9-2.1 eV as bulk material), onto a substrate surface. Under ultra-high vacuum conditions (UHV, $<10^{-8}$ mbar), sub-monolayer sheaths of pure Cs show WFs as low as 1.5 eV.

Neutral beam injection systems based on negative ions for fusion are, however, typically operated under non-UHV conditions. In such non-baked systems, water is the most abundant residual gas, which will react with the Cs in the ion source. During operation, the conversion surface of the ion source undergoes alternating vacuum, gas and plasma phases.

Measurements in vacuum under different background pressures and after short plasma pulses reveal WFs as low as 1.2 eV, attributable to the formation of Cs oxides, which indicates that the interplay of Cs with residual water may lead to the optimal converter surface for H^-/D^- sources. The ultra-low WF-layers are not stable over long plasma pulses. Hence, procedures to reliable obtain these layers at the ITER background pressures and maintain them during long pulses, needs to be developed.

Therefore, the required layer characteristics in terms of thickness and chemical composition and to its reliable synthesis and persistence during ions source operation needs to be identified. To this end, campaigns under different conditions ranging from UHV to water-rich environments are performed using a comprehensive set of diagnostics. Besides the absolute photoelectric WF determination, tuneable diode laser absorption spectroscopy (TDLAS) is used for the absolute quantification of neutral Cs. A quartz micro balance (QMB) measures the adsorbed thickness of the Cs layer.

Primary author: KLOSE, Nikolas

Co-authors: WIMMER, Christian (Max-Planck-Institut f. Plasmaphysik); FRIEDL, Roland; FANTZ, Ursel (Max-Planck-Institut für Plasmaphysik)

Presenter: KLOSE, Nikolas

Session Classification: Oral Session

Track Classification: Fundamental processes in ion sources and plasmas