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Work Function Measurements in BATMAN Upgrade using LEDs Revealing Remarkably Low Values

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The work function of a surface can be determined by measuring the nA-photocurrents arising from the irradiation by light of different wavelengths. When the chosen photon energies are close to the work function, this energy threshold can be calculated using the Fowler method. As a novelty using fiber coupled LEDs as a light source of sufficient power, the work function inside a negative ion source was determined following this approach.
State of the art negative hydrogen ion sources for neutral beam injectors, as developed for ITER, rely on the surface conversion process of H and H_x^+ from a low temperature plasma at a cesiated surface with low work function. In order to reach longer pulse durations at high extraction currents, a stable work function, which is governed by cesium dynamics, impurities, and the interaction with the plasma, is crucial. Taking on the challenges of measuring small nA-photocurrents in a corresponding environment, a method was developed to investigate the work function for the first time ever directly inside a high-performance negative ion source, namely BATMAN Upgrade, which measures an eighth of the size of the ITER sources. As the chosen method relies on the observation of photocurrents inside the plasma chamber, its applicability is limited to the vacuum phase between plasma pulses. Besides gaining first experience with the new approach, an analysis of the work function's absolute value is of great interest for a verification of the previous assumption that cesium adlayers cause the work function to be the one of bulk cesium, i.e., $\chi = 2.14$ eV. Additionally, monitoring the temporal stability was a major aim for the conducted experiments, as work function variations are expected to impact the source performance.
The contribution shows the results for the first campaign of work function measurements during operation of BATMAN Upgrade. By conditioning the source with continuous cesium evaporation and accordingly increasing source performance, the work function's correlation with the extracted ion and electron current densities was investigated. It was thereby demonstrated that the work function in a well-conditioned source is regularly well below the minimum value of thick cesium layers and hence significantly below the assumed value. Comparably low results have recently been achieved in a dedicated laboratory experiment [1].

[1] A. Heiler et al., "Ultra-low work function of cesiated surfaces and impact of specific hydrogen plasma species", this conference.

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