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# Work Function of the Caesiated Converter Surface at the BATMAN Upgrade H- Ion Source at Different Source Parameters

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Negative hydrogen ion sources for neutral beam injection (NBI) systems for nuclear fusion experiments rely on the surface production of negative hydrogen ions on a low work function converter surface. The state-of-the-art technique for the generation of low work function surfaces is steady evaporation of the alkali metal Cs into the ion source. As the Cs layers are affected by residual gases from the background pressure (typically $10^{-7}$–$10^{-6}$ mbar) during vacuum phases as well as by reactive hydrogen particles and energetic photons during plasma phases, non-pure Cs layers are present and are subject to temporal dynamics. In consequence, the achievement of a stable and reliably good ion source performance (i.e., high extracted ion current and technically manageable co-extracted electron current) is challenging and in particular an issue for long pulse operation (1 h required in the case of ITER).
To control the work function and get insight into temporal dynamics in different operational scenarios, a work function diagnostic has been developed that is suitable for harsh ion source environments. High power fiber-coupled LEDs are used to irradiate the surface with different photon energies in vacuum phases between plasma pulses, and the resulting photocurrents are measured to evaluate the absolute work function according to the Fowler method. The diagnostic is successfully benchmarked at a dedicated laboratory experiment and is applied at the BATMAN Upgrade test bed at IPP, which is equipped with an ion source 1/8 of the size of the ITER NBI source and has recently been upgraded for long pulse operation. It is shown that the work function is subject to pronounced temporal dynamics and is far below the one of bulk Cs in a well-conditioned source. Investigations are performed both in $H_2$ and $D_2$ for operational scenarios with different pulse lengths to identify correlations between the work function, parameters such as the Cs density and ion source performance.

## Funding Agency

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Yes

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