Development of a Caesium Free Hydrogen Negative Ion Source Based on a Pulsed ICP Discharge

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The negative ion sources planned for use in ITER's NBI system will utilise caesium to enhance the surface production of H^- and D^- ions. However it has been suggested [1] that for DEMO/commercial fusion reactors that a similar Cs injection rate to ITER is likely to lead to NBI operational problems during the reactor's lifetime. Fusion NBI ion sources of the future will need to dramatically reduce their rate of Cs consumption, or will require alternatives to Cs for H^- surface production. The aim of this work is to evaluate the performance of a Cs free RF inductively coupled ion source, operated in a pulsed regime to generate a high density of volume produced negative ions. Such sources have been developed for use in damage free plasma etching of future Ultra-Large Scale Integrated circuits [2]. Source performance has been characterised by Langmuir probe measurements of plasma density and temperature at the centre of the discharge and in proximity to the extraction grid, together with RFA measurements of the extracted ion beam. The source will also be used for testing materials which have shown promise as Cs alternatives for H^- surface production, such as boron doped diamond [3], for comparison with conventional magnetically filtered, caesiated fusion H^- ion sources.

References:

[1] R.S. Hemsworth, D. Boilson, "Considerations for the development of neutral beam injection for fusion reactors or DEMO," *AIP Conference Proceedings*, 1869, 2017.

[2] S. Samukawa, "Ultimate Top-Down Etching Processes for Future Nanoscale Devices: Advanced Neutral-Beam Etching," *Japanese Journal of Applied Physics*, 45, 4A, pp. 2395-2407, 2006.

[3] A. Ahmad, C. Pardanaud, M. Carr`ere, J.-M. Layet, G. Cartry *et. al.*, "Negative-ion production on carbon materials in hydrogen plasma: Influence of the carbon hybridization state and the hydrogen content on H-yield," *Journal of Physics D: Applied Physics*. 47, 2014.