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# Electron Cyclotron Resonance Ion Sources for Solar and Semiconductor Applications

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A high current microwave ion source (MWS) has been developed by Phoenix Nuclear Labs (PNL) to cater the high beam current requirement for various applications in semiconductor, solar and power device fields. The source consists of solenoid electromagnets surrounding a microwave resonant cavity producing a magnetic field tuned to match the electron cyclotron resonance (ECR) of 2.45 GHz microwaves. The microwave power induces production of ions efficiently which are extracted into a high current, low emittance beam with a set of electrostatic lenses. The extracted ion beam is couple to a DC electrostatic accelerator that transport the ion beam to the end station via suitable mass analyzing magnet and focusing elements.

The MWS ion source design does not feature any filaments, electrodes, or other consumable components which guarantees exceptional reliability and long lifetimes. This also enables to minimize particles and metals contamination in the system. Continuous uptime of >99% and thousands of hours of operation have been demonstrated on multiple systems. The total beam current extracted from the ECR ion source is typically about 50 -100 mA at 50 kV for Hydrogen. For Deuterium beam it is 50-75 mA at 50 kV with an average current density of 125 mA/cm$^2$. Extracted deuterium beam currents as high as 90 mA have been measured with current density of 225 mA/cm$^2$. In addition, the high gas efficiency of the ion source allows a relatively low input gas flow rate of 1-5 SCCM, which reduces vacuum pumping requirements for the rest of the system.

With the push to reduce the cost of the wafers used for applications in Semiconductor, Solar, LED and other power device applications, SOI Technology and Smart Cut Technology which uses Hydrogen ions for bonding and splitting wafers are getting lots of attention. With the very good Hydrogen beam current which boosts up throughput for those applications, it is important to characterize the beam quality and corresponding metrics.

An overview of the PNL ion source will be given and operational data along with some test results on the beam quality on wafers will be reported.

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