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Development of a High Temperature Black Body Source for ITER ECE Diagnostic

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For ITER Electron Cyclotron Emission (ECE) diagnostic, there is a requirement of high-temperature black body radiation source operating at atmospheric pressure. This source needs to be operated at high temperature (~ 500 0C) having a microwave emissivity > 0.95 in the frequency band 100-500 GHz, and > 0.75 for 500-1000 GHz. Moreover, the radiation surface should have temperature uniformity within ±10 0C. This source will be utilized for characterizing the ITER ECE measuring instruments like Michelson Interferometer and radiometer.

For this purpose, a radiation source has been designed and developed. The radiation source consists of a heater and an emissive surface. The emissive surface is made of silicon carbide (SiC), as it has high thermal conductivity, low thermal coefficient of expansion, excellent machinability, good vacuum compatibility and high emissivity in the mm-wave region. The diameter of the emissive surface is 150 mm.The suitable heating element has been used having high resistivity and good oxidation resistance nature.

This paper deals with the design, analysis, and characterization of the developed high-temperature black body radiation source in the frequency range 100 to 1000 GHz. The Finite Element Method based software, "COMSOL", has been used to analyze and optimise the heating coil design to get desired temperature uniformity of the emissive surface. Experimentally, the temperature uniformity is measured by an IR camera and microwave emissivity is measured by the Michelson interferometer.The operating temperature of 500 0C is achieved in the developed source with temperature uniformity within ±10 0C. The short and long-term temperature stability up to ± 2 0C and ± 10 0C respectively has also been achieved. Further, the microwave emissivity of ~0.8 - 0.9 has been observed over wideband 100-1000 GHz. The above measured values are in compliance with ITER requirement.

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