BENEFITS OF HIGHER-ORDER PARTICLES IN SIMULATING MICROWAVE PLASMA INTERACTIONS USING A PARTICLE-IN-CELL CODE

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Researchers often would like to apply Particle-in-Cell (PIC) methods to model cold, high pressure plasmas in order to discern any kinetic, nonlinear or space charge effects. However, the PIC method typically does not perform well at low temperatures and high densities due to limitations on time and space scales for numerical and practical reasons. One of these limitations is the requirement to resolve the Debye length. Failure to resolve the Debye length in a PIC simulation typically results in artificial heating of the plasma known as grid heating. For applications such as plasma processing, the rate of plasma production is a sensitive function of the electron temperature, so grid heating can make simulation results entirely unreliable. The use of higher-order particle algorithms that smooth out the particle current and charge can help to eliminate this unphysical heating and allow cold, dense plasmas to be simulated using PIC. We present results of using higher-order particles for modeling a plasma sustained by microwaves and we compare to results using standard first-order particles. Specifically, we compare the electron temperature, sheath size, and rate of plasma formation for simulations with an argon gas of 0.05 Torr pressure with an applied microwave power at 2.45 GHz.