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High-Speed Particle-in-Cell Simulation Parallelized with Graphic Processing Units for Low Temperature Plasmas for Material Processing[1]

MIN YOUNG HUR, Pusan National University, JOHN VERBONCOEUR, Michigan State University, HAE JUNE LEE, Pusan National University — Particle-in-cell (PIC) simulations have high fidelity in the plasma device requiring transient kinetic modeling compared with fluid simulations. It uses less approximation on the plasma kinetics but requires many particles and grids to observe the semantic results. It means that the simulation spends lots of simulation time in proportion to the number of particles. Therefore, PIC simulation needs high performance computing. In this research, a graphic processing unit (GPU) is adopted for high performance computing of PIC simulation for low temperature discharge plasmas. GPUs have many-core processors and high memory bandwidth compared with a central processing unit (CPU). NVIDIA GeForce GPUs were used for the test with hundreds of cores which show cost-effective performance. PIC code algorithm is divided into two modules which are a field solver and a particle mover. The particle mover module is divided into four routines which are named move, boundary, Monte Carlo collision (MCC), and deposit. Overall, the GPU code solves particle motions as well as electrostatic potential in two-dimensional geometry almost 30 times faster than a single CPU code.

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