Modelling of Modern Plasma Processing Reactors: Plasma Physics and Surface Chemistry

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For modern plasma processing, there is a need to perform kinetic simulations of large plasma devices using the particle-in-cell (PIC) technique due to relative ease of implementing the method, and that it can be parallelized effectively over many processors and accelerated on GPUs. At PPPL we have developed two codes EDIPIC-2D and LTP-PIC-3D. EDIPIC-2D is an open-source code that includes features for simulations of practical devices and has been used for modelling of several plasma devices. LTP-PIC-3D is a high-performance scalable PIC code which incorporates best programming practices and multi-level parallelism. This code was upgraded to operate efficiently on the latest CPU/GPU architectures for additional performance improvements. Energy conserving or implicit methods were implemented to speed up simulations [1]. Effects of numerical noise in simulations using PIC code need to be analysed and considered [2]. These codes have been applied to study plasma processing applications, such as capacitively coupled plasmas [3], electron beam produced plasmas [4], inductively coupled plasmas, and hollow cathode discharges. To model surface processes we used a combination of quantum chemistry methods and molecular dynamics [5].

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