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Anode Layer Hall Plasma Accelerator: Recent Progress and Challenges

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The anode layer Hall plasma accelerator is a gas discharge device that is applied to the electric propulsion system of a spacecraft or a satellite and to ion beam-assisted deposition technology. Ions are accelerated electrostatically to several hundred to several thousand electron-volts in a quasi-neutral plasma with a closed electron $E \times B$ drift. In Southwestern Institute of Physics, experimental and numerical investigations have been carried out in order to understand the physics of the anode layer Hall plasma accelerator and improve its performance. The plasma non-uniformity named "Rotating Spoke" phenomenon, which is critical for the efficiency of the anode layer Hall plasma accelerator, has been simulated by a three-dimensional Particle-in-Cell simulation. The result indicates that an azimuthal electric field generated by the "Rotating Spoke" phenomenon bring an additional electron drift to the anode in axial direction. Therefore, much of the input power is wasted by the "Rotating Spoke" phenomenon. The experiments of a hundred-mm anode layer Hall plasma accelerator suggests that it is possible to produce a concentrated ion beam even without grids. Simulation results reveal that the concentrated ion beam is induced by the position of the ionization region and the special emission surface which is determined by the magnetic field topology. Further investigations are focused to the means for the suppression of the "Rotation Spoke" phenomenon to break present technological limits and the controlling of the ion beam by adjusting the magnetic field topology for various applications.