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2D Hybrid Fluid-Analytical Model of Inductive/Capacitive Plasma Discharges[1]

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A fast 2D hybrid fluid-analytical TCP reactor model was developed using the finite elements simulation tool COMSOL. For a typical chlorine reactor, the simulation time was less than 90 minutes (less than 30 minutes for argon) on a moderate 2 GHz CPU workstation with 4GB of memory. Both inductive and capacitive coupling of the source coils to the plasma are included in this model. The model also includes a capacitive bias option for the wafer electrode. A bulk fluid plasma model, which solves the time-dependent plasma fluid equations for the ion continuity and electron energy balance, is coupled with an analytical sheath model. An actual vacuum sheath of variable thickness is modeled with a fixed-width sheath of variable dielectric constant. The sheath heating is treated as an incoming heat flux at the plasma-sheath boundary, and a dissipative term is added to the sheath dielectric constant. A gas flow model solves for the steady state pressure, temperature and velocity of the neutrals. By varying the model parameters (e.g., pressure, input power, source coil configuration, chamber height), we observe the effect on the plasma (e.g., uniformity, density, capacitive coupling). We are also working on a multi-frequency sheath model, and on coupling a particle code to the hybrid fluid-analytical model to obtain the ion energy and angular distributions at the substrate.

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