COMPUTATIONAL OPTICAL AND DISCHARGE PHYSICS GROUP
University of Illinois at Urbana/Champaign

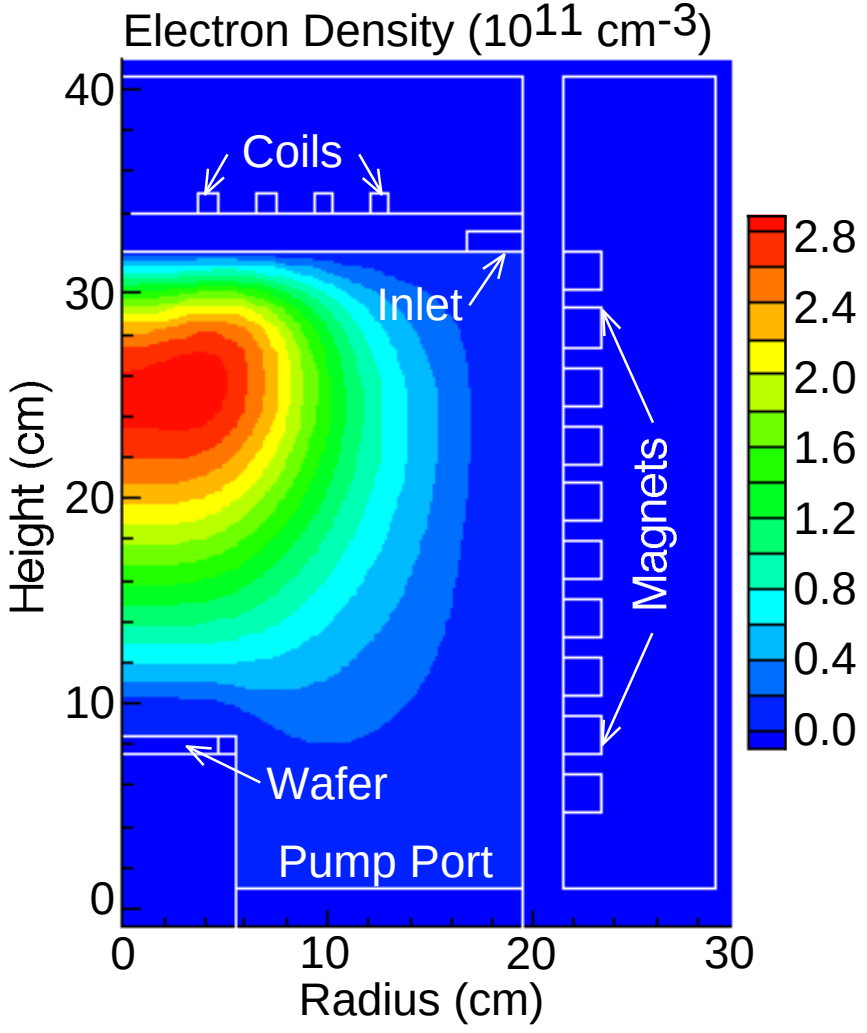
- **The Computational Optical and Discharge Physics Group (CODPG) at the University of Illinois develops computer simulations and computer aided design tools for low temperature plasma processes and equipment.**
  - **Plasma materials processing for microelectronics fabrication**
  - **Plasma remediation of toxic gases**
  - **Pulsed Power**
  - **Lighting sources and plasma display panels**
  - **Lasers and laser-materials interactions**
- **These physics based, design capable models are jointly developed and validated with industrial collaborators. The models may be delivered and licensed to our collaborators.**

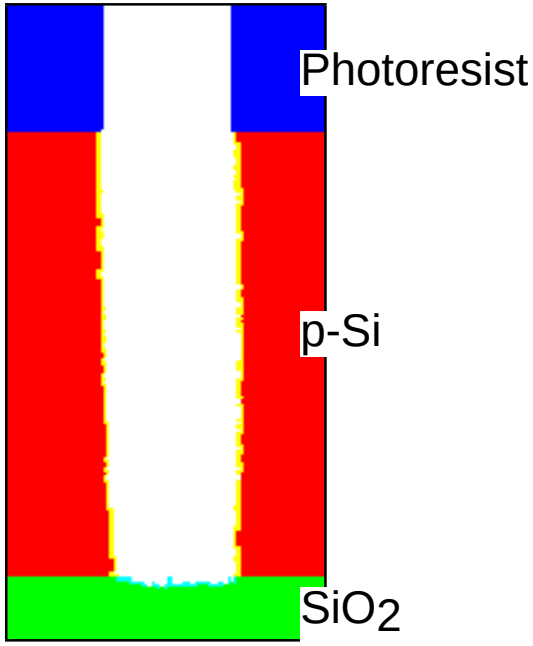
HYBRID PLASMA EQUIPMENT MODEL (HPEM)

- **The Hybrid Plasma Equipment Model (HPEM) is a comprehensive modeling platform developed by the CODPG for low pressure (< 10's Torr) plasma processing reactors. The HPEM is capable of addressing:**
  - **Inductively Coupled Plasma (ICP) tools.**
  - **Reactive Ion Etchers (RIE)**
  - **Electron Cyclotron Resononance (ECR) sources**
  - **Magnetron sputter and Ionized Metal Physical Vapor Deposition (IMPVD)**
  - **Remote Plasma Activated Chemical Vapor Deposition (RPACVD)**
  - **Dust particle transport in plasma tools**
- **There are 2-d and 3-d versions of the HPEM.**
- **The HPEM is linked to profile simulators developed in the CODPG which predict the evolution of submicron features.**
- **The HPEM is now in use at 10 major semiconductor chip and plasma equipment manufactures.**

Example: HPEM SIMULATION OF p-Si ETCHING

- The HPEM has been applied to analysis of a large variety of plasma etching systems. Here we show the electron density in an Inductively Coupled Plasma p-Si etching tool and the resulting etch profile.

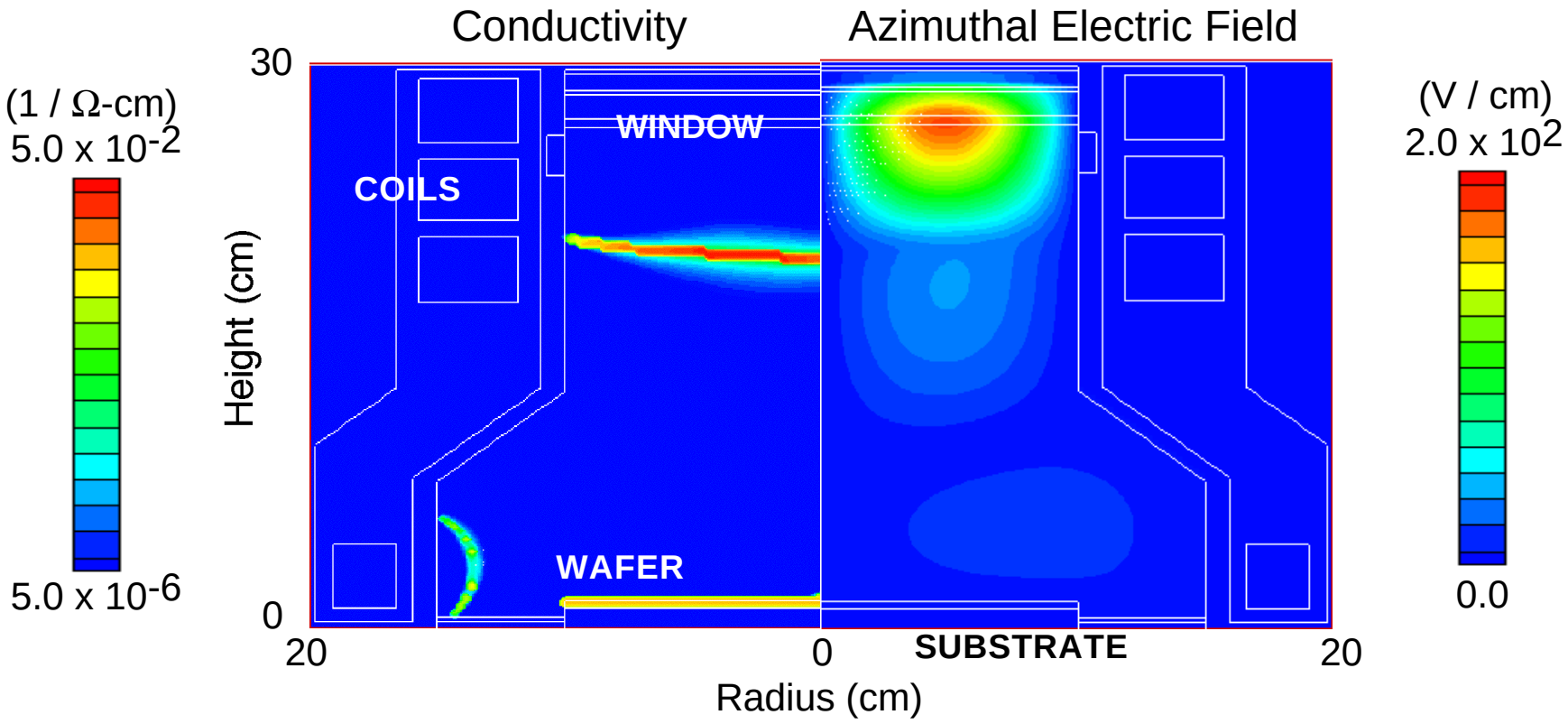




Gas Mixture:	Cl_2/Ar = 96/4
Pressure:	4 mTorr
Gas flow rate:	30 sccm
ICP power:	1000 W
Bias voltage:	100 V

Example: MICROWAVE ECR PLASMA SOURCE

- A Finite Difference Time Domain (FDTD) module has been developed for the HPEM to address microwave excitation of plasma sources.
- Here we show the plasma conductiviity and microwave field intensity (2.45 GHz) in an Electron Cyclotron Resonance (ECR) reactor. The injected mode is TE_{01}.



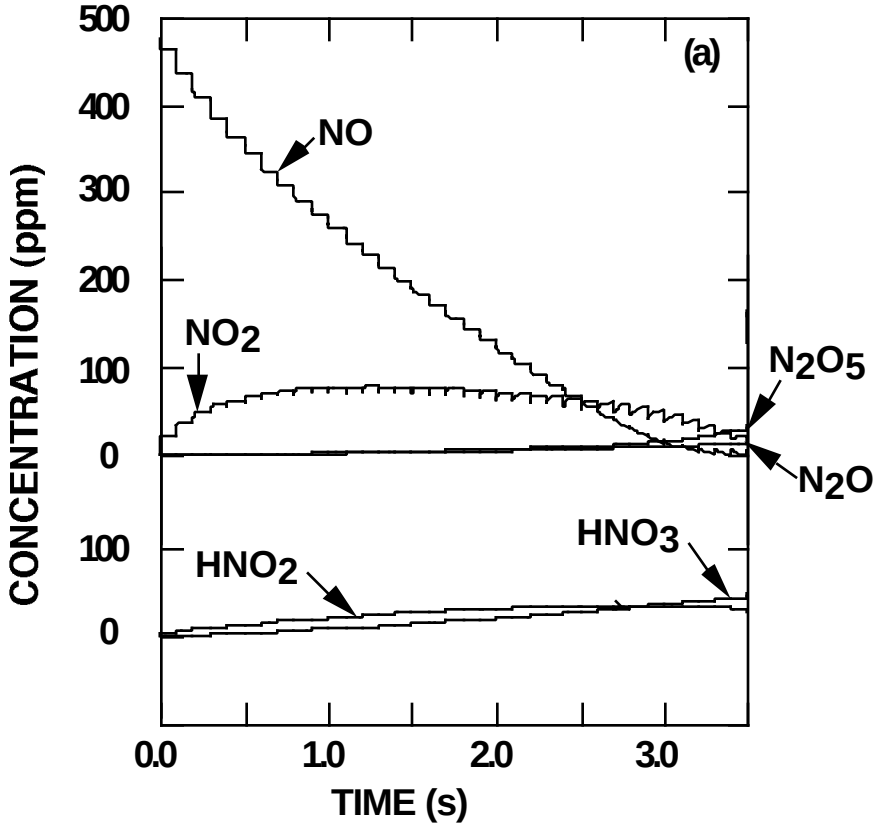
- N_2, 750 Watts, 1 mTorr, 10 sccm

PLASMA REMEDIATION OF TOXIC GASES

- The CODPG has developed a suite of computer models to investigate the chemistry and hydrodynamics of plasma remediation of toxic gases.
- Remediation of volatile organic compounds (VOCs) and NO_X have been studied with the goal of determining reaction pathways and optimizing efficiency.

- Example: Density of nitrogen oxides during plasma remediation of NO_X from humid air in a Dielectric Barrier Discharge

- $N_2/O_2/H_2O/NO$ = 85/5/10/500 ppm 400 K, 1 atm



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