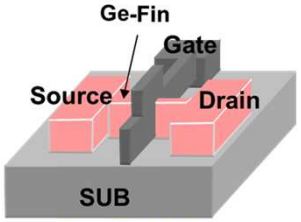
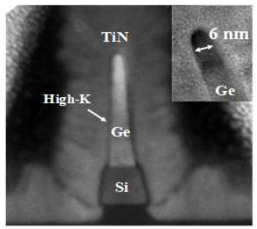
# TC17 - Emerging Plasma Nanotechnologies

## Plasma Physics/Chemistry, Material/Surface/Interface Science and Nano-Engineering

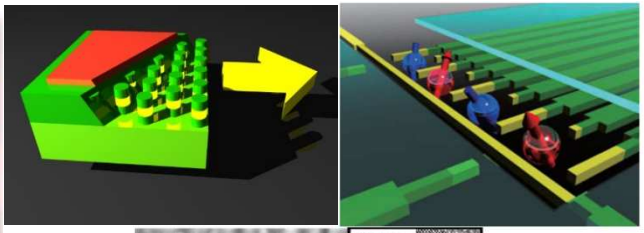
## Nano-materials and Optical/Electrical/Spintronics Nanodevices

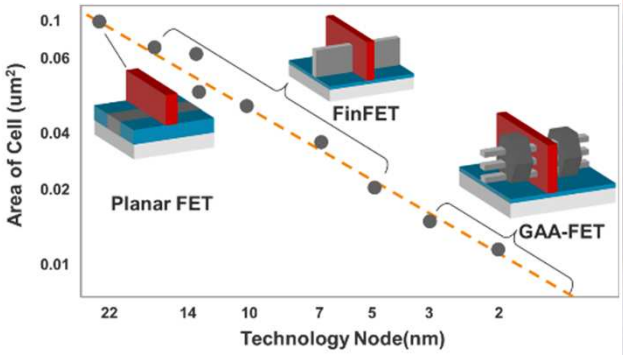


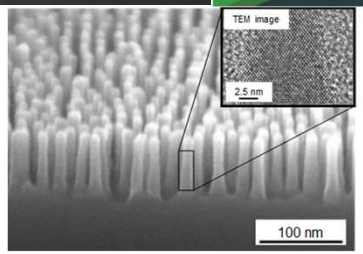

Ge Fin FETs



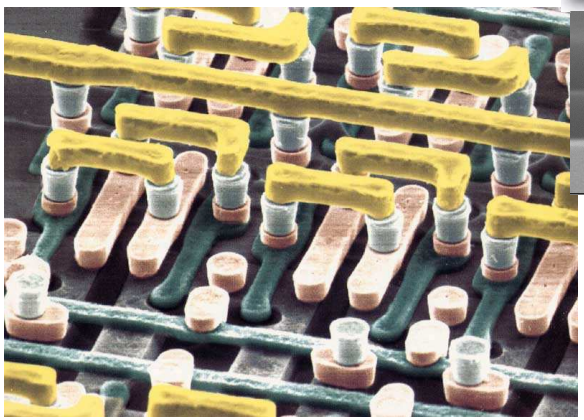




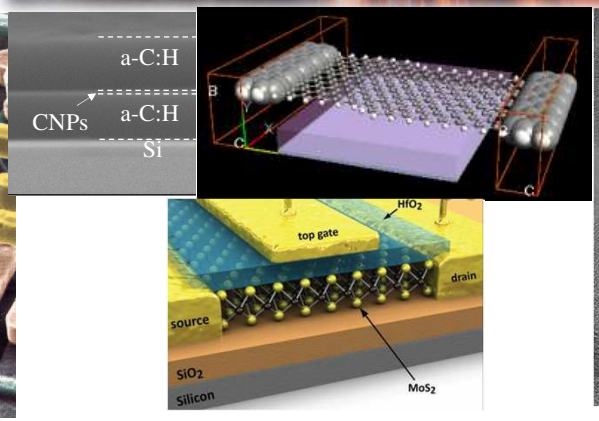


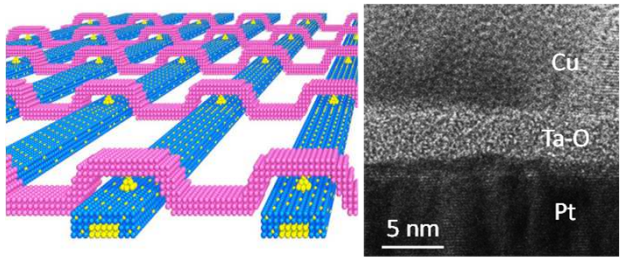

Quantum dots



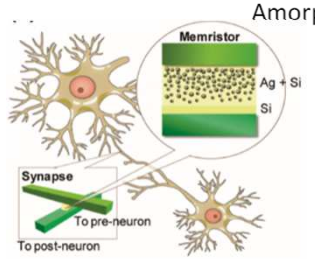
Ultra-Large Integrated Circuit and 3D Heterogenous Integration Devices




New Materials:
Carbon Nanotubes, Graphene,
2D Materials and Nanoparticles

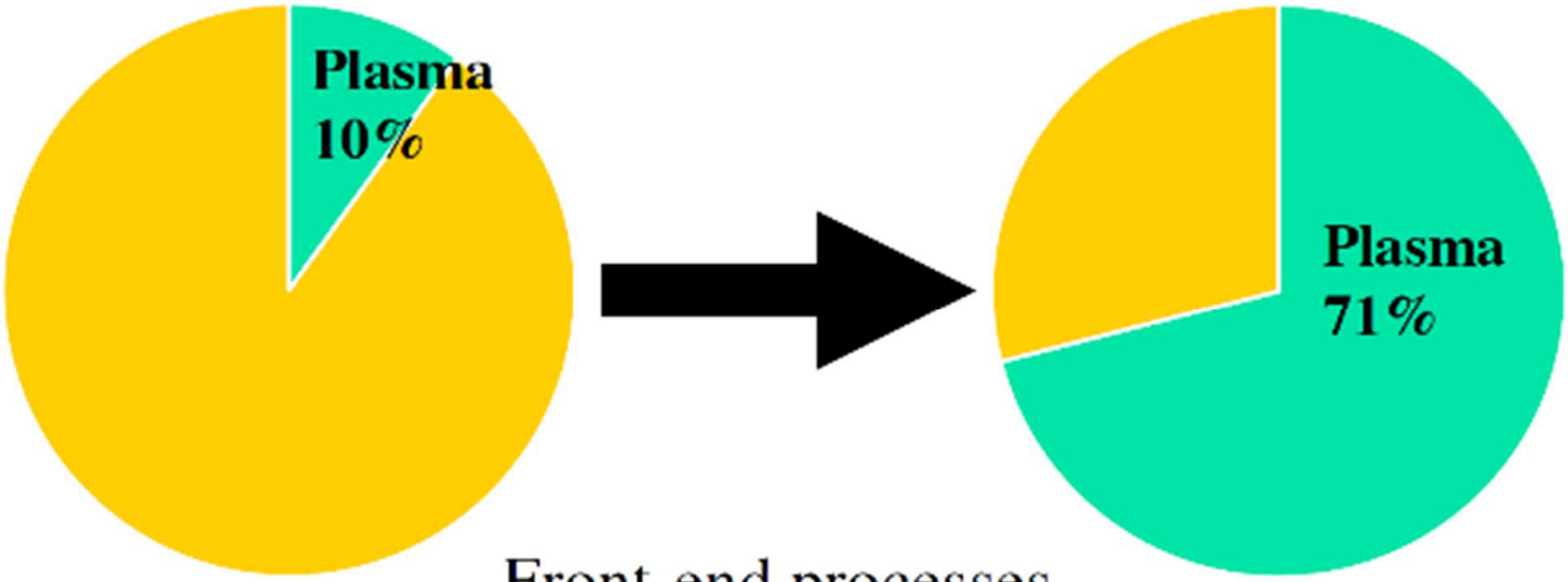



Amorphous Phase

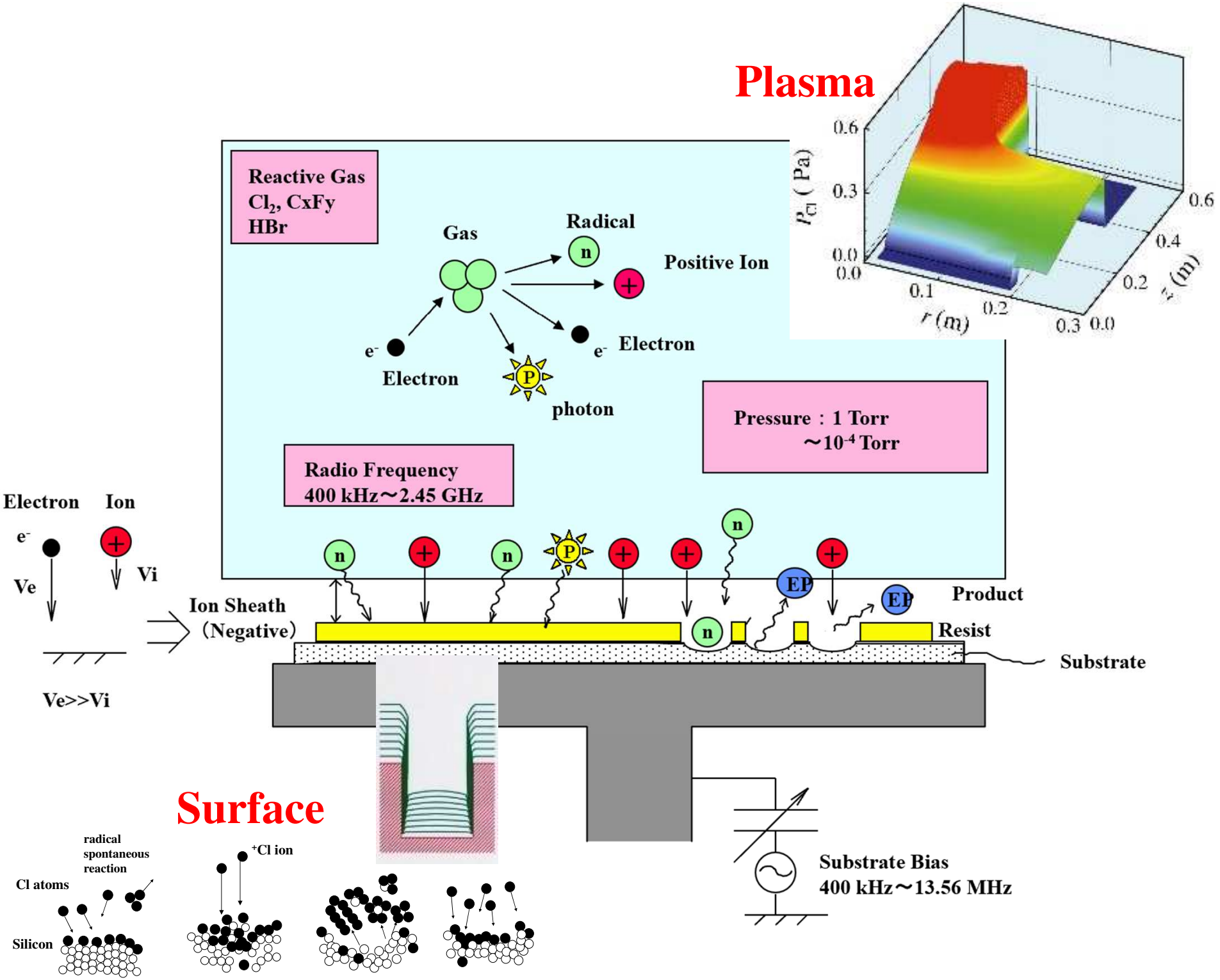



Neuromorphic Devices

# Percentage of Plasma Processes in Semiconductor Manufacturing Processes




**Key Technologies for Nano-fabrication and Nano-device**


Plasma
Reactive Gas
Cl2, CxFy
HBr
Gas
Radical
Positive Ion
Electron
Electron
photon
Pressure : 1 Torr
~10-4 Torr
Radio Frequency
400 kHz~2.45 GHz
Electron
Ion
Ve
Vi
Ve>>Vi
Ion Sheath
(Negative)
EP
Product
Resist
Substrate
Surface
radical
spontaneous
reaction
Cl atoms
Silicon
+Cl ion
Substrate Bias
400 kHz~13.56 MHz

# TC17 - Emerging Plasma Nanotechnologies

| | Name Surname | Affiliation | E-mail | Scientific field of activity |
|---|---|---|---|---|
| Chair | Seiji Samukawa (Japan) | Tohoku University | seiji.samukawa.e2@tohoku.ac.jp | Plasma nanomanufacturing and green nanotechnology |
| Co-Chairs | John P. Verboncoeur (USA) | Michigan State University | johnv@egr.msu.edu, | Plasma Physics |
| | Uros Cvelbar (EU) | Jozef Stefan Institute | uros.cvelbar@guest.arnes.si | Plasma processing of nanomaterials for energy storage and sensing devices |
| Members | Masaharu Shiratani (Japan) | Kyushu University | siratani@ed.kyushu-u.ac.jp | Plasma Electronics |
| | Peter Ventzek (USA) | Tokyo Electron America Inc. | peter.ventzek@us.tel.com | Plasma process for semiconductor device manufacturing |
| | Kremena Makasheva (EU) | Université Paul Sabatier | kremena.makasheva@laplace.univ-tlse.fr | Plasma deposition of nanocomposites, reactive plasmas, biomedical nanotechnologies |
| | Jong-Shinn Wu (Taiwan) | National Yang Ming Chiao Tung University | chongsin@faculty.nctu.edu.tw | Plasma Modeling |

# Summary

## 1. Topics of Interest

**Atomic Layer Etching**
**Atomic Layer Deposition**
**Atomic Layer Modification**
**Doping, Nanoparticle Formation**
**Nanostructure Fabrication and Analysis**
**Electron/Optical/Spintronics/Quantum device**
**Quantum Computing**
**Bio-medical Applications**

## 1. Main Objectives of Technical Committee

**To fabricate high performance nanodevices and nano-systems, atomic layer and damage-free plasma nanomanufacturing technologies are indispensable. For this purpose, it is essential to develop methods for generating and transporting charged particles, UV photons, and reactive species on the surface to suppress damages and to control atomic layer surface chemical reactions in plasma processing. Achieving control of atomic layer surface chemical reactions requires diagnostics and sensors for both the plasma and resultant surface states but also models (phenomenological to the first principles) that can predict process results. Therefore, our final target is the development and implementation of intelligent plasma nanomanufacturing technologies in accordance with Industry 4.0 and 5.0 standards.**