What is plasma?

- Plasma
- Plasma processing fundamentals: frequency and others
- Low pressure gas plasma diagram
- Plasma cleaning in wedge bonding
- March plasma systems

refer to Nordson March Plasma training

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2018.11.30

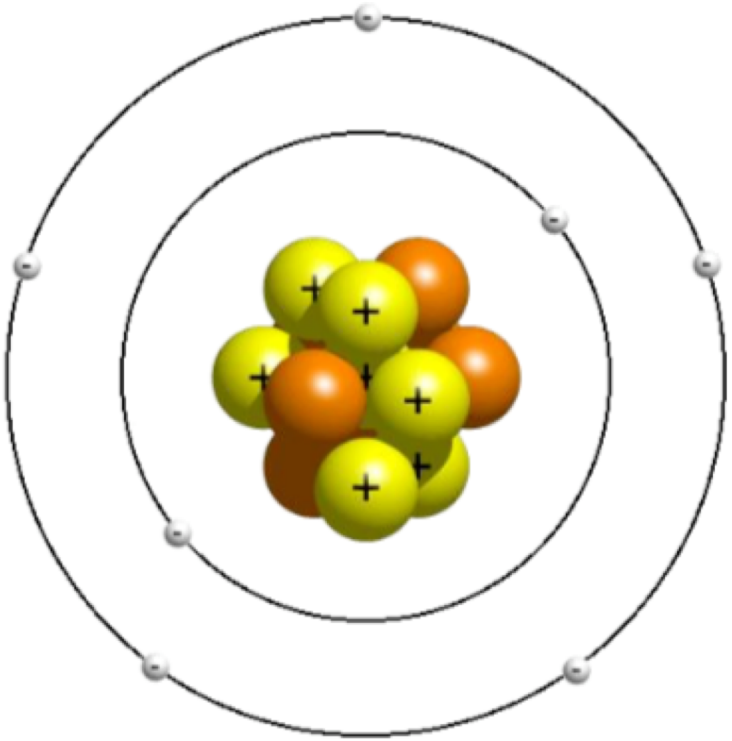
Special Topic - 49

Plasmas are All Around Us

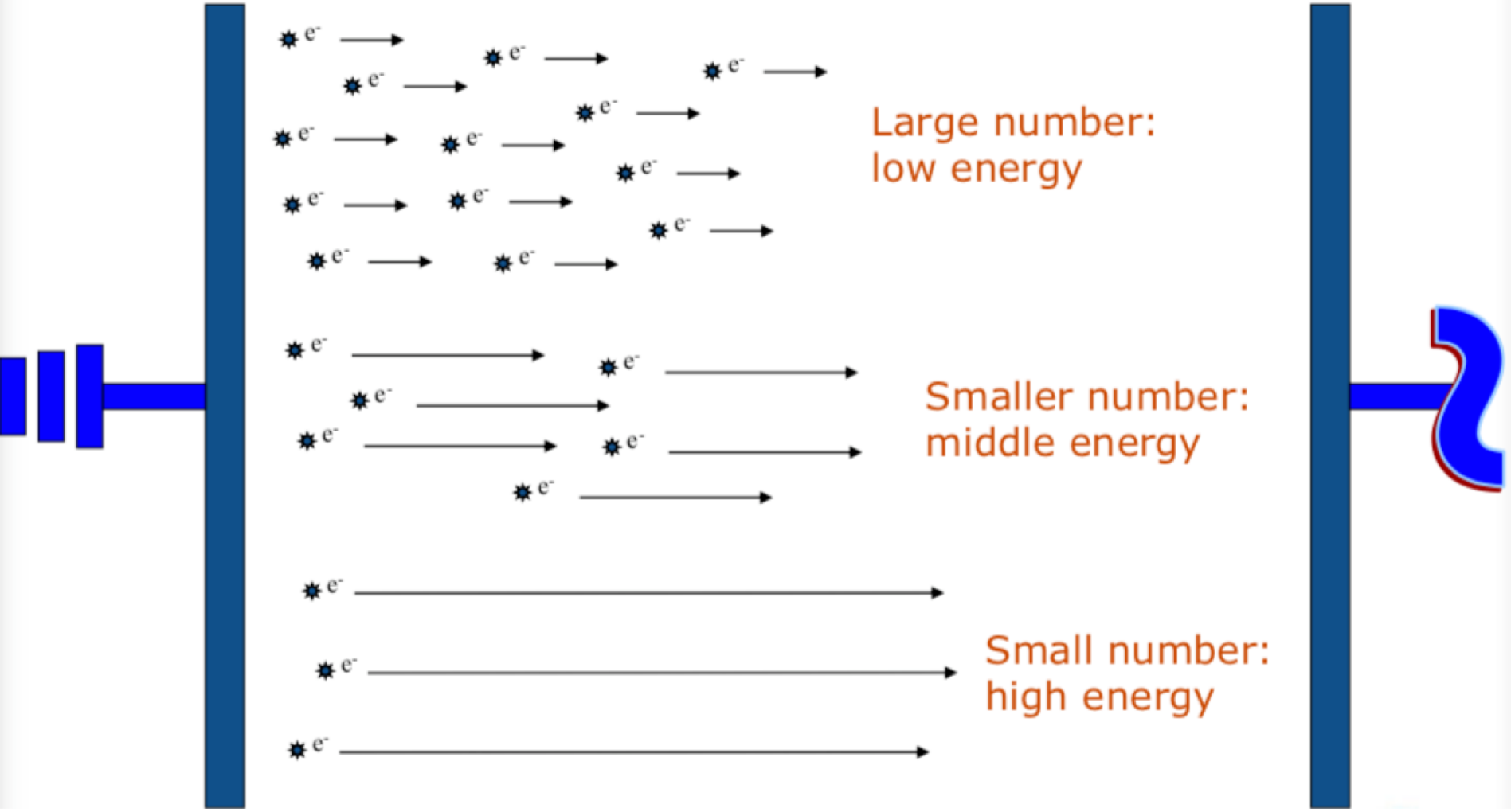
The Atom

An atom consists of positive protons in the nucleus and negative electrons that circulate around the nucleus. An equal number of positively and negatively charged particles lead to overall neutrality.

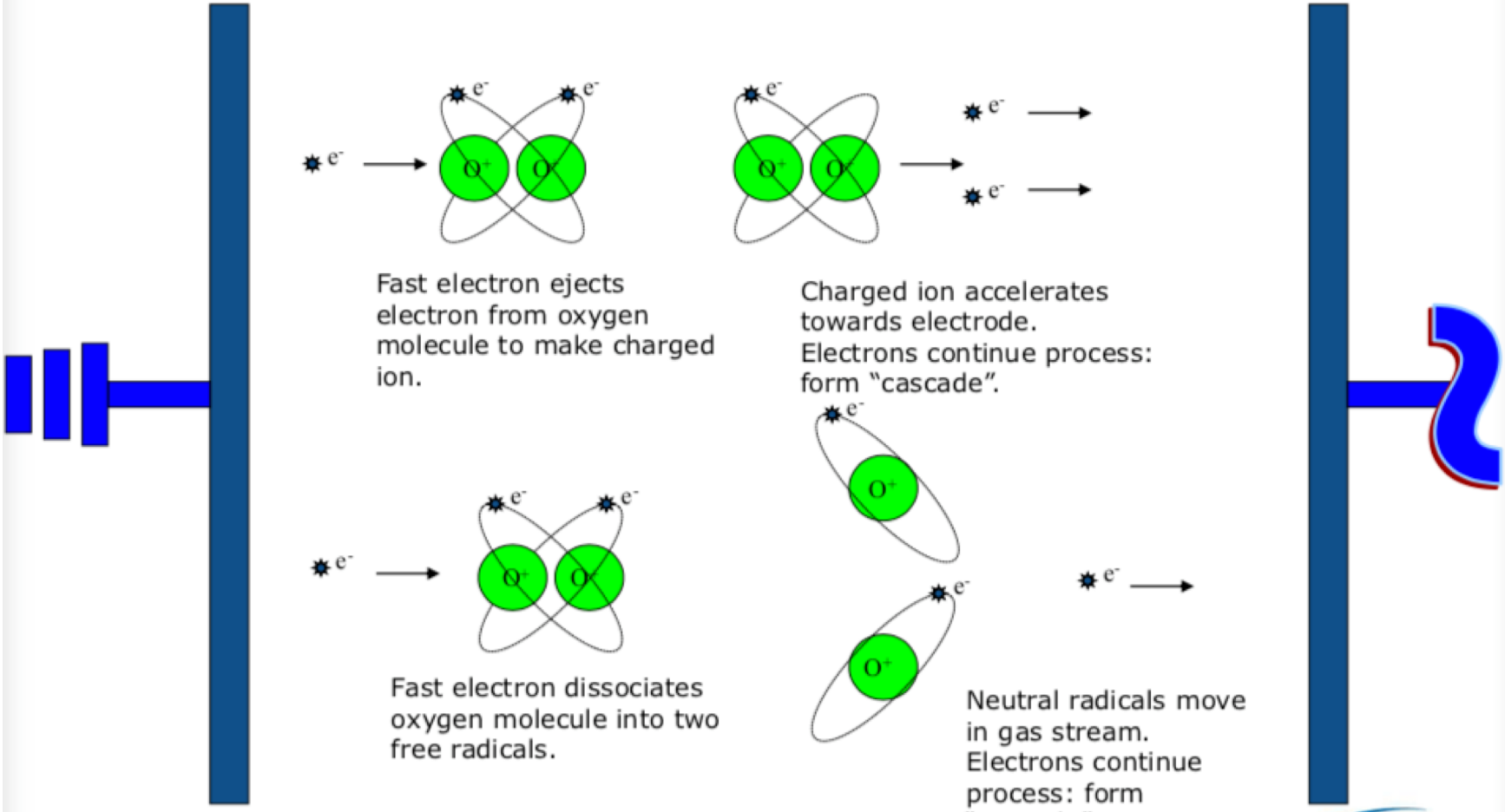
Nitrogen Atom



An electric field accelerates electrons, available in the gas and from the electrodes. The result is a population of electrons with a range of energies.



In a gas plasma, ions are formed which sputter inorganic material from the surface and free radicals are formed which react with and remove organic contaminants



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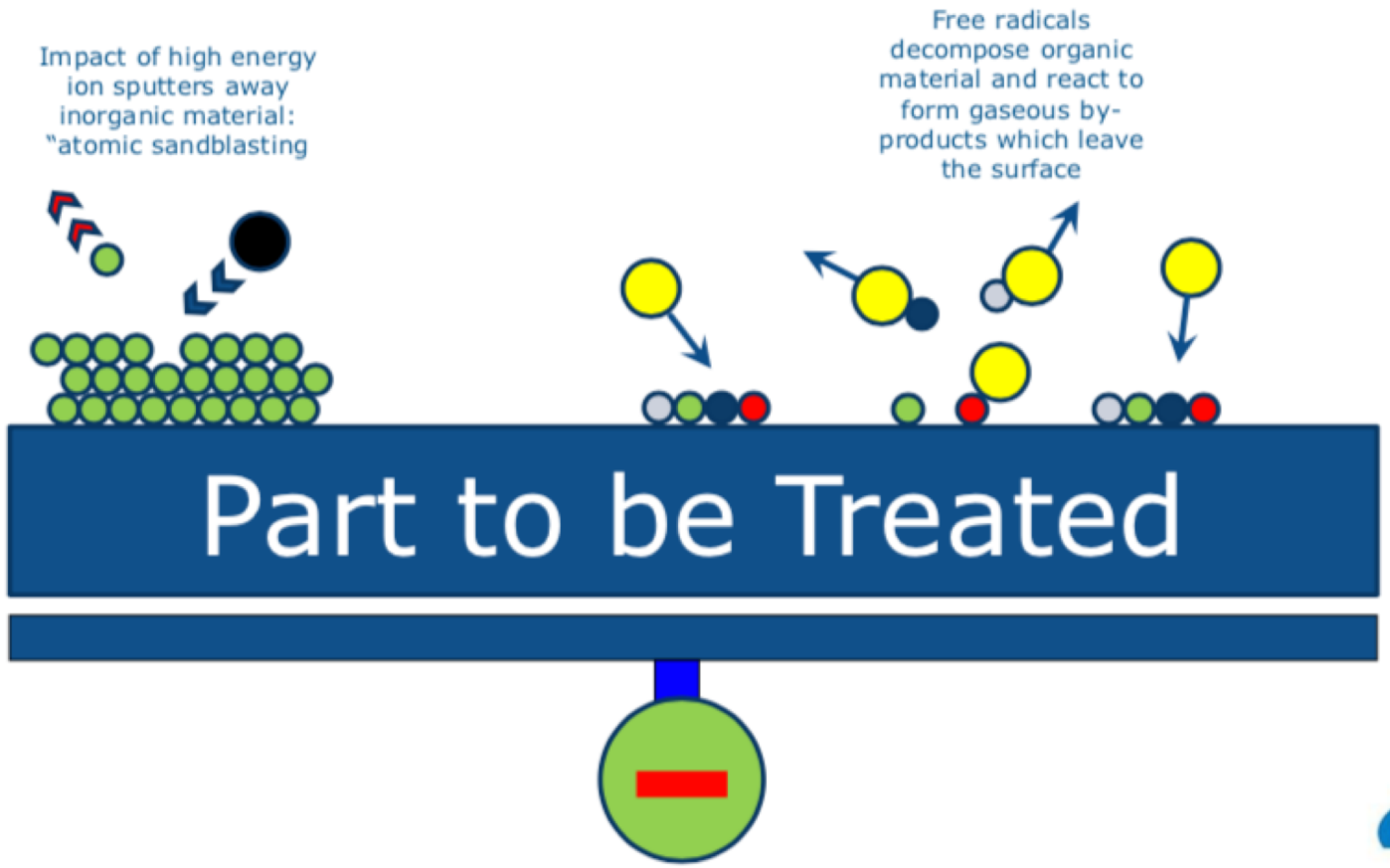
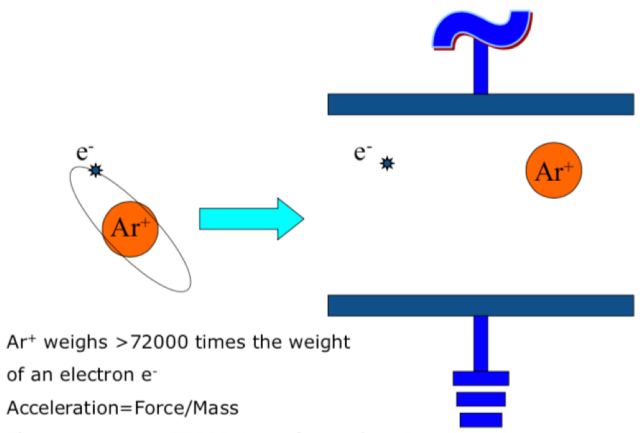


Sputtering: atomic sandblasting



Ions

- Result From Removal or Addition of Electron
  - Positive (Cation): Ar^+
  - Negative (Anion): Cl^-
- Physically Active
  - Sputtering – Follow Electric Field
  - Activity is Function of Mass
- Positive Ions
  - Removal of Electron to Form Ion
    - $Ar + e^- \rightarrow Ar^+ + 2e^-$
  - Argon Ion Physically Removes Contaminant
    - Ar^+ + Contaminant → Contaminant in Gas Phase

Free Radicals

- Atom/Molecule with Unpaired Electrons
  - No Charge
    - Follow Gas Flow
    - No Kinetic Energy Acquired from Electric Field – No Sputtering
- Very Chemically Reactive
  - Gas:Solid Chemical Reaction
  - Gas Phase By-products Produced
- Formed by Dissociation of Chemical Bonds
  - $O_2 + e^- \rightarrow 2O\cdot + e^-$
  - $O\cdot$ + Organic → $CO_2 + H_2O$
  - Chemically Active Oxygen Radicals React with Organic to Produce Gas Phase By-products

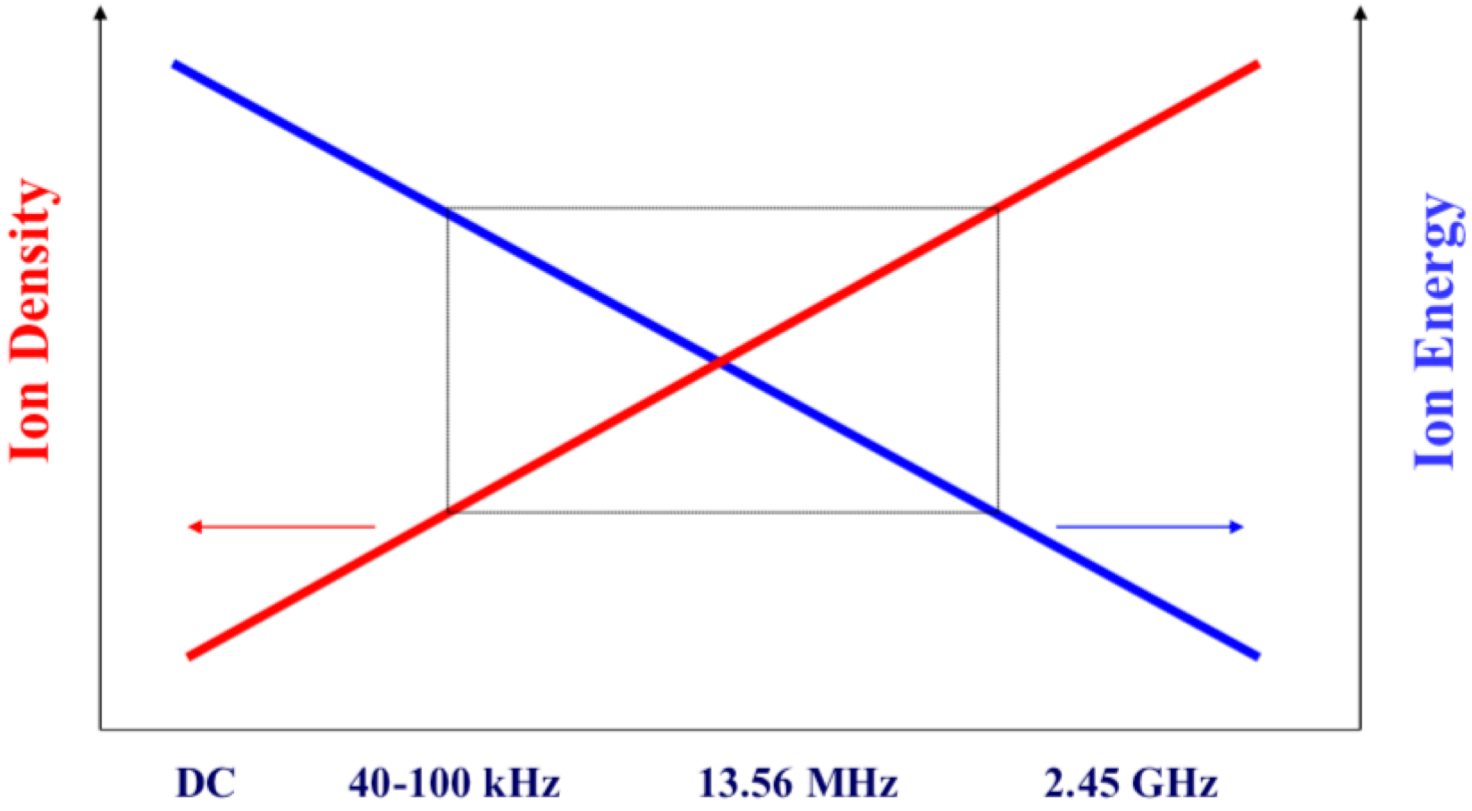
Secondary Products

- "Stable" Recombination Products
- Chemically Active
  - Example: Ozone

    $O_2 + e^- \rightarrow 2O\cdot + e^-$

    $O\cdot + O_2 \rightarrow O_3$
    - Strong Oxidizer
    - Remove Organics

Effect of Exciting Frequency

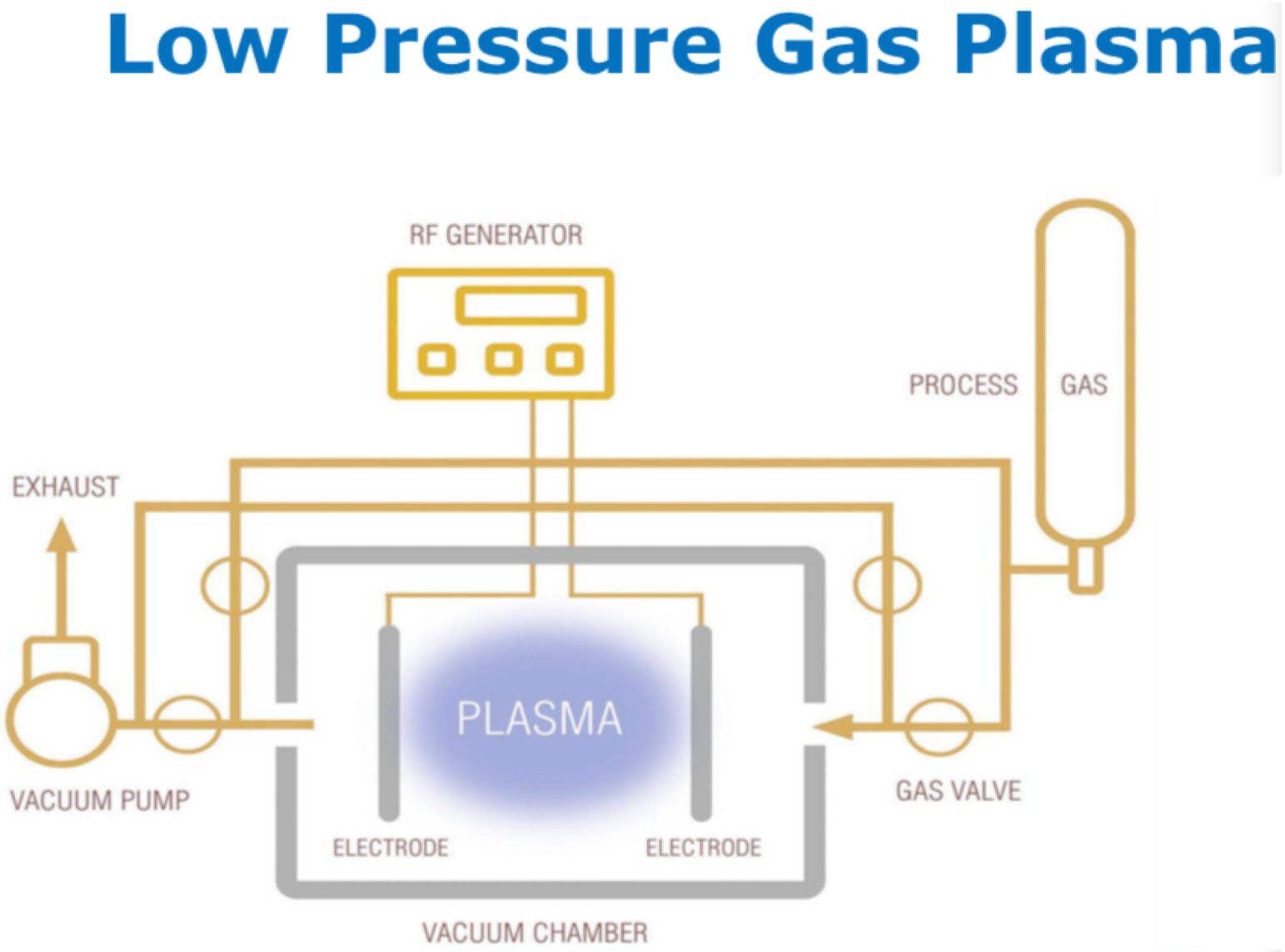


Also, DC plasma.....

Process Parameters

- gas chemistry
- gas pressure
- gas flow
- plasma power: ion density and ion energy
- field strength
- temperature
- time
- uniformity
- chamber contents

Plasma mode:


Low Pressure Gas Plasma
RF GENERATOR
PROCESS GAS
EXHAUST
PLASMA
VACUUM PUMP
GAS VALVE
ELECTRODE
ELECTRODE
VACUUM CHAMBER

Plasma cleaning before wedge bonding

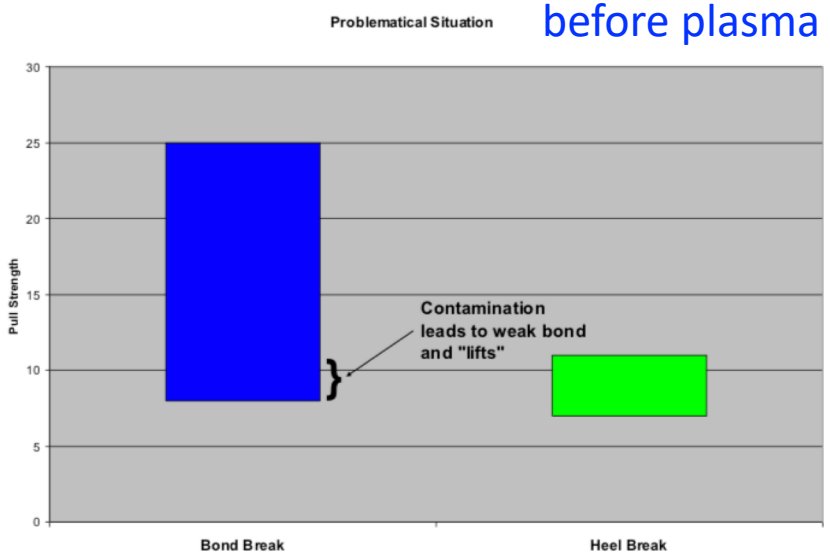
Wire Bond Testing: Failure Mechanisms

1. Non-bond on ic
2. Lift on ic
   i.e wire bond weak
3. Heel break at ic*
4. Wire break*
5. Heel break at PCB*
6. Lift on PCB
   i.e wire bond weak
7. Non-bond on PCB

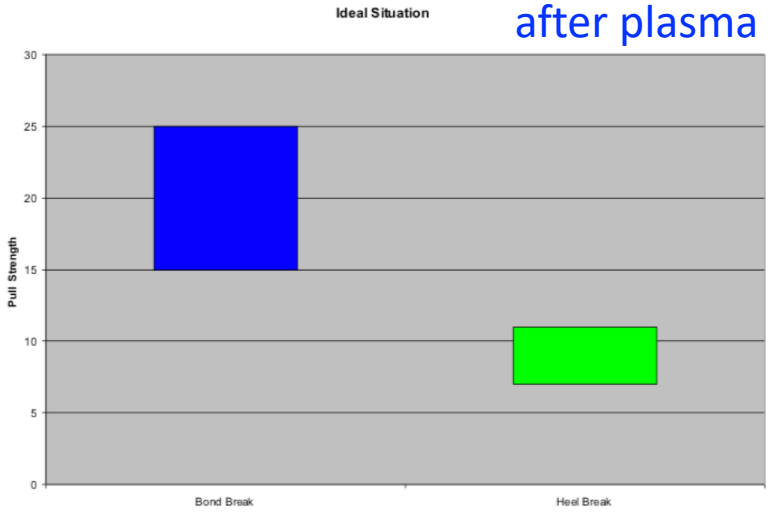
*These failure mechanisms are acceptable

Plasma removed organic contamination from the bond pads, eliminating non-bonds and lifts and ensuring that all wire breaks during testing were heel breaks

before plasma



after plasma



March Plasma Systems

Nordson MARCH