بسم الله الرحمن الرحيم

If you do not go after what you want,

you will never have it.

If you do not ask, the answer will always

be no.

If you do not step forward, you are

always in the same place.

8th Spring Plasma School @ Port Said

4 -7 March 2023

PLASMA PHYSICS & LIFE

By

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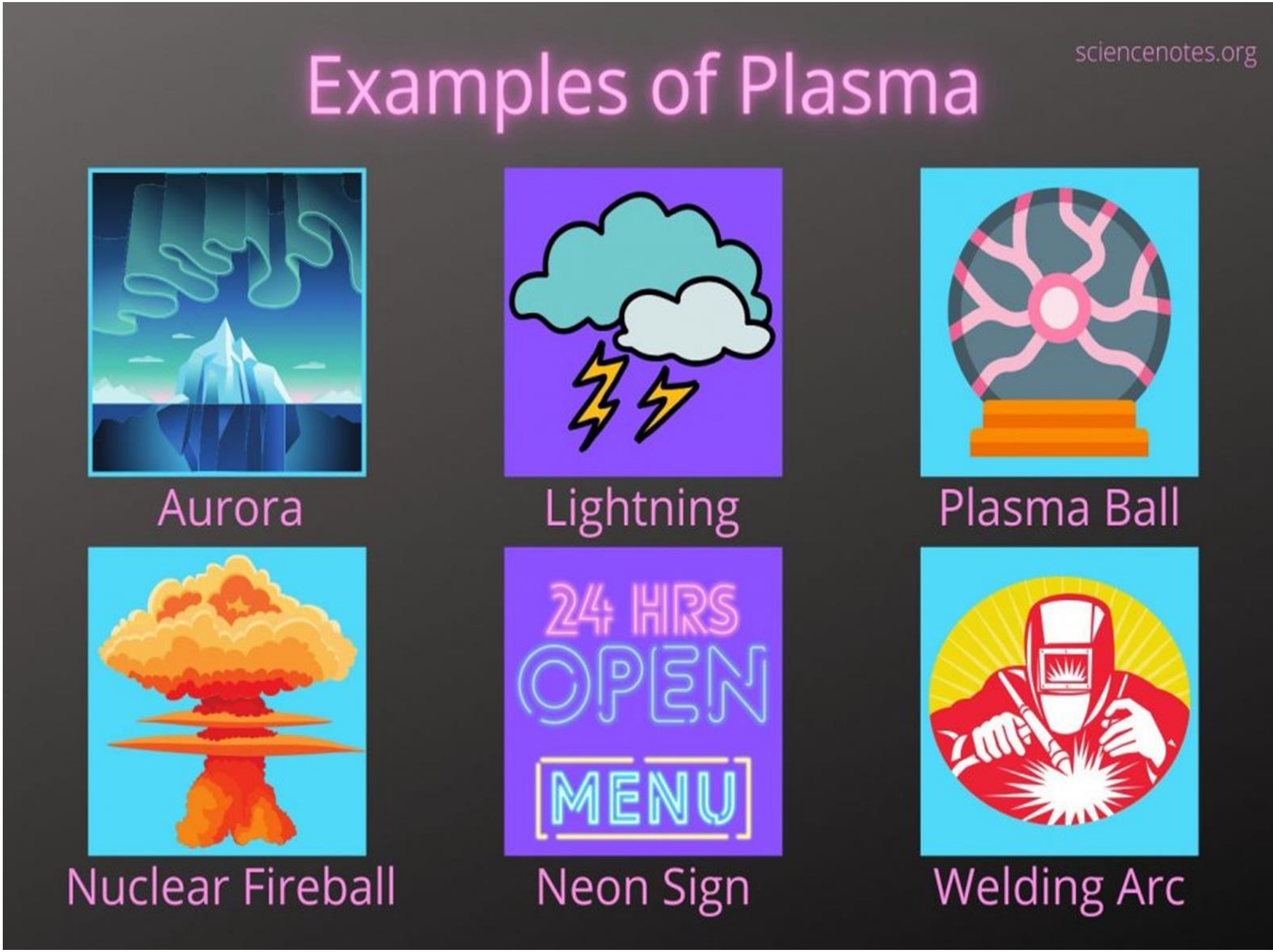
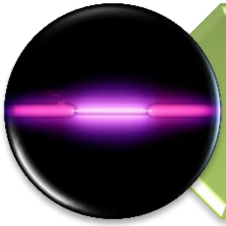

sciencenotes.org
Examples of Plasma
Aurora
Lightning
Plasma Ball
24 HRS
OPEN
MENU
Nuclear Fireball
Neon Sign
Welding Arc

Outlines:

Plasma as Green Energy

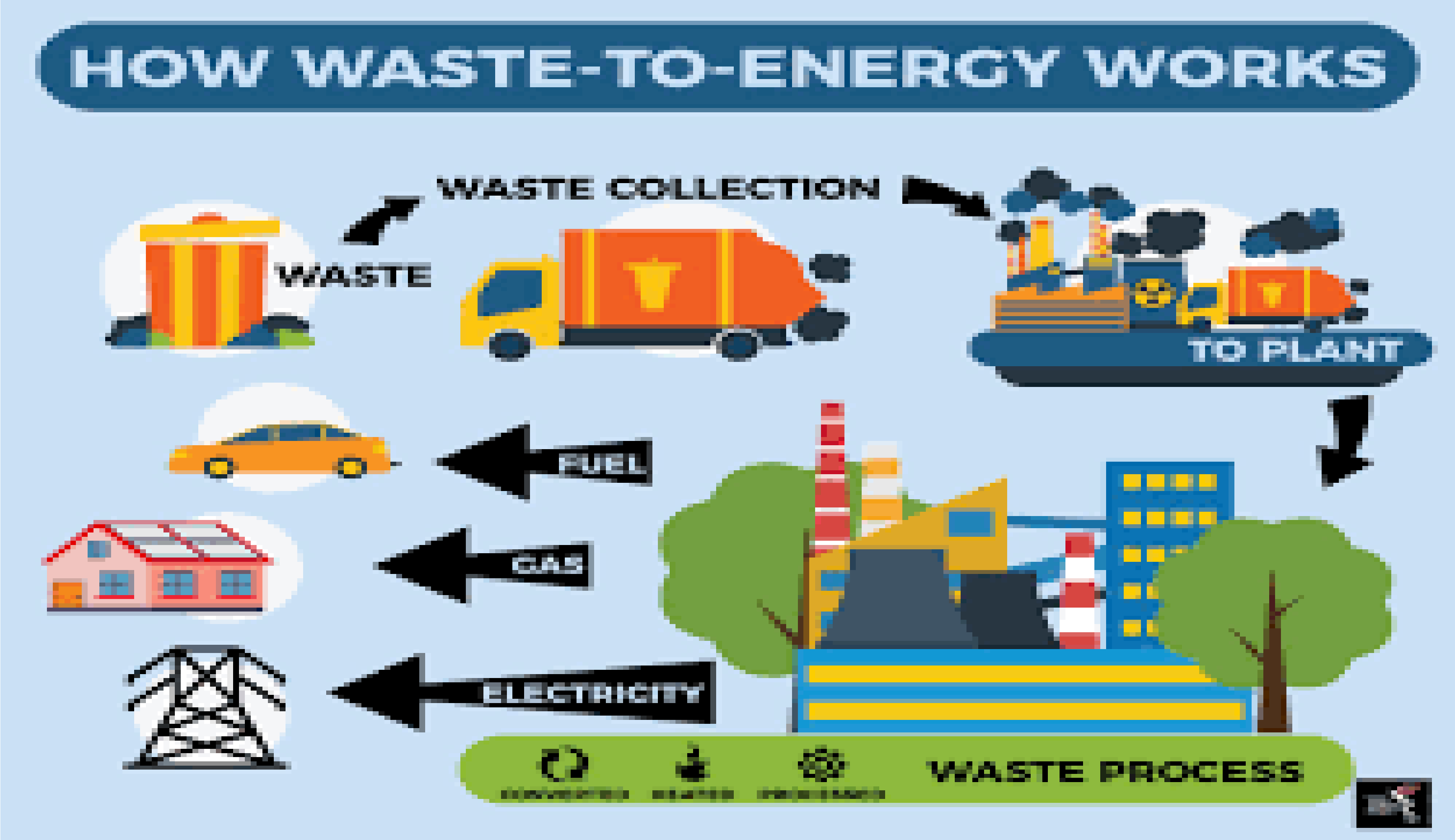


Plasma Science for Modern Nanotechnology

Pinch, Confinement & Focus Plasma

Diagnostic Tools

Plasma as Green Energy



Plasma as Green Energy

- Wastes emerged to be an opportunity to generate valuable materials and products for human demands. Particularly in non-developed countries, recycling of resources have become a prominent revenue source for society. Numerous researches are conducting and developing to manage wastes by new technologies over the world day by day.

- **Plasma arc recycling:**

A relatively new type of waste treatment called plasma arc recycling (sometimes referred to as "plasma recycling," "plasma gasification," "gas plasma waste treatment," "plasma waste recycling," and various other permutations of the words plasma, gas, arc, waste, and recycling) aims to change all this. It involves heating waste to super-high temperatures to produce gas that can be burned for energy and rocky solid waste that can be used for building. Supporters claim it's a cleaner, greener form of waste treatment.

- **What kind of waste do we make?**

Plasma as Green Energy

- Plasma torches like this are the heart of a plasma recycling plant. They can create temperatures of over 10,000 degrees—enough to blast waste materials apart into their constituent atoms so they can be reassembled into less harmful materials. Photo by Ames Laboratory courtesy of US Department of Energy, published on Flickr.

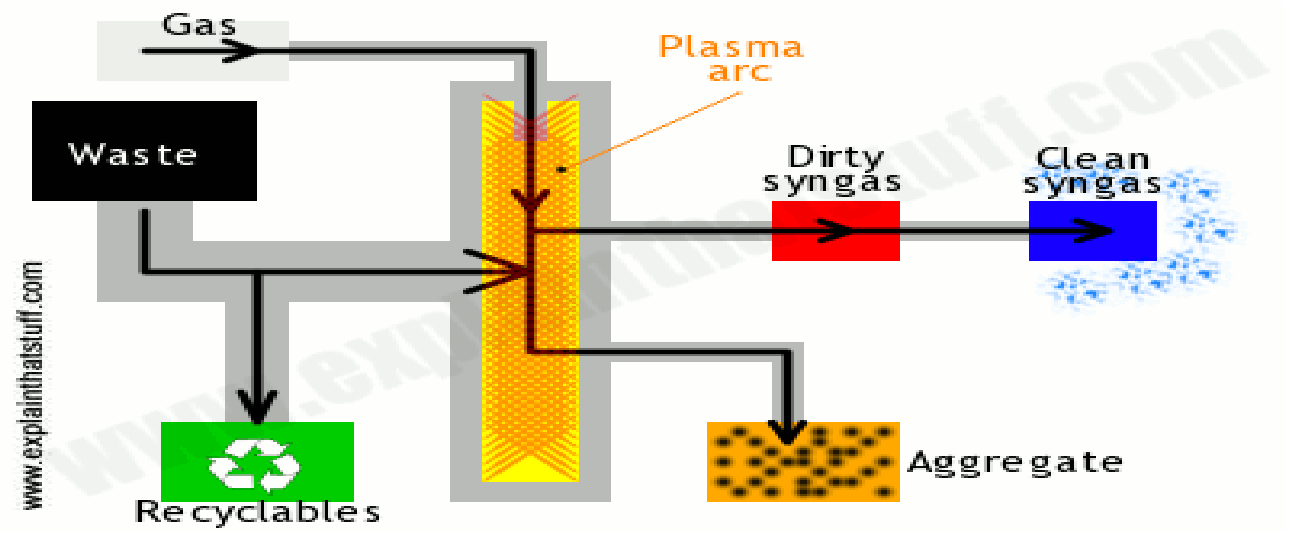
Plasma as Green Energy

1- The waste is burned in a closed container at extremely high temperatures (to destroy as many toxic chemicals as possible);

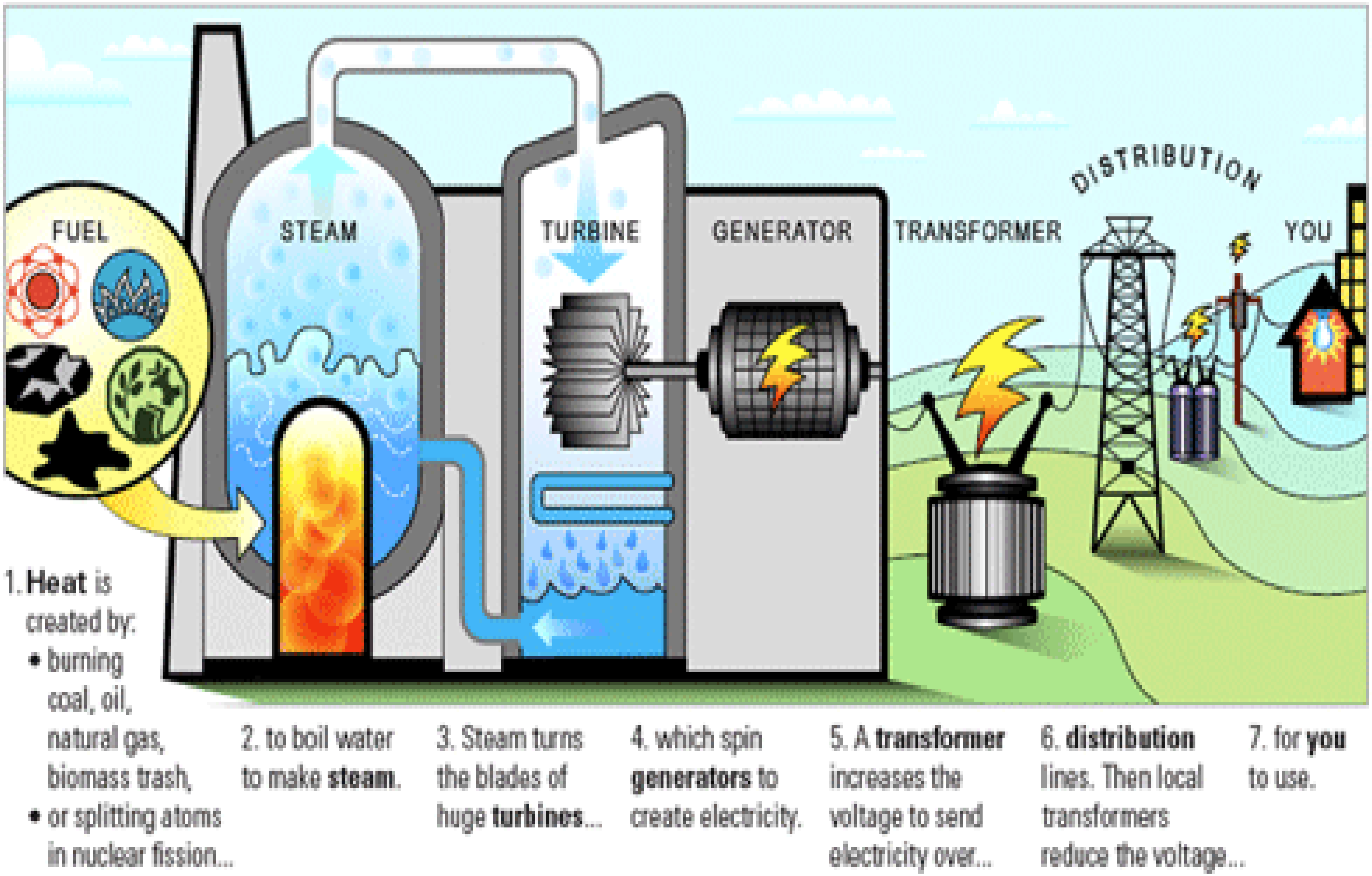
2- Pollution from the smokestack (chimney) may be trapped and "scrubbed" clean before it's released (using an electrostatic smoke precipitator);

3- A very tall smokestack is used, (theoretically) to disperse any remaining pollution in the wind;

4- The energy released by burning the waste is captured and used to boil water, drive a steam turbine, and generate electricity.



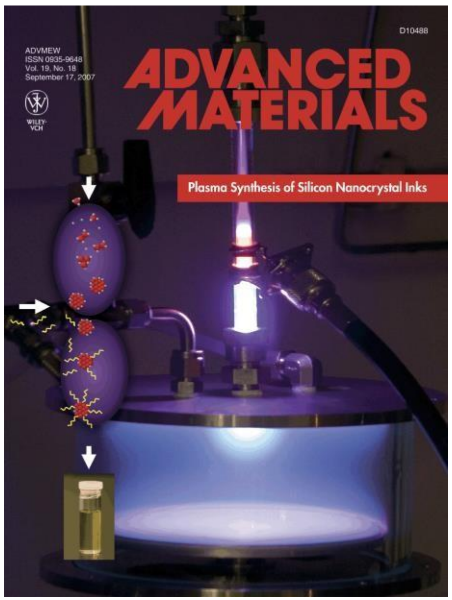
Plasma as Green Energy



Revolutionary Nanosynthesis Technologies

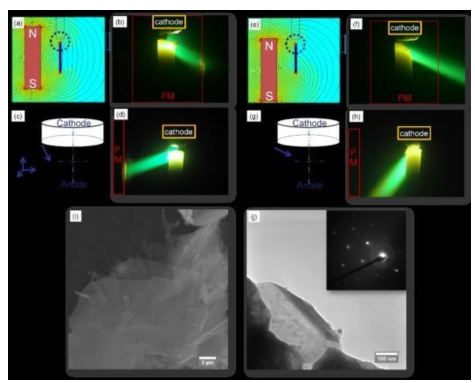
Nanomaterials have the potential to revolutionize many fields, including electronics, energy storage, and environmental and pharmaceutical applications.

- **Many existing methods of nanosynthesis use low pressure (10^{-3}-10^{1} torr) and higher pressure ($\leq$ 1 atm.) plasmas to produce a broad range of nanomaterials with various nanostructures:**



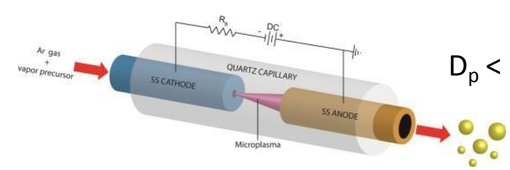
Low pressure plasma synthesis of silicon nanoparticles.

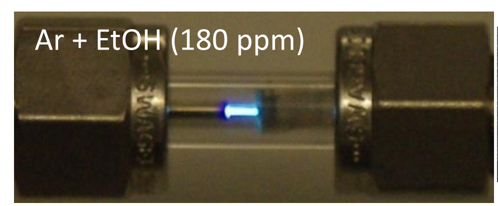
Mangolini and Kortshagen Advanced Materials 2007 Univ. of Minnesota

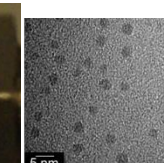


Magnetically controlled arc synthesis of graphene at 500 torr.

Volotskova et al, Nanoscale, 2010 GWU-PPPL-CSIRO







Microplasma synthesis of nano diamonds at 1 atm. pressure

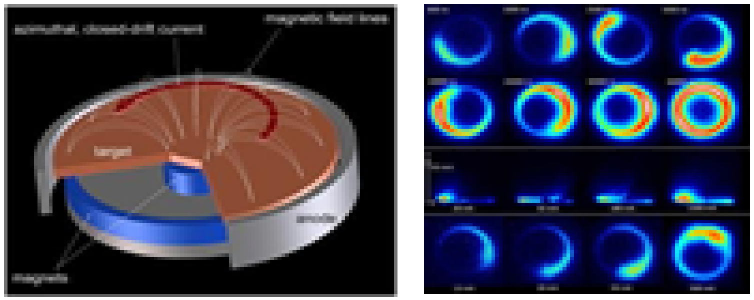
A. Kumar et al., Nature Comm. 2013 Case Western Reserve Univ.

Emerging Plasma-Based Nanotechnologies

- Use low-pressure magnetized plasmas to produce new nanomaterials:

- Synthesis of nanostructural functional coatings using magnetized plasmas

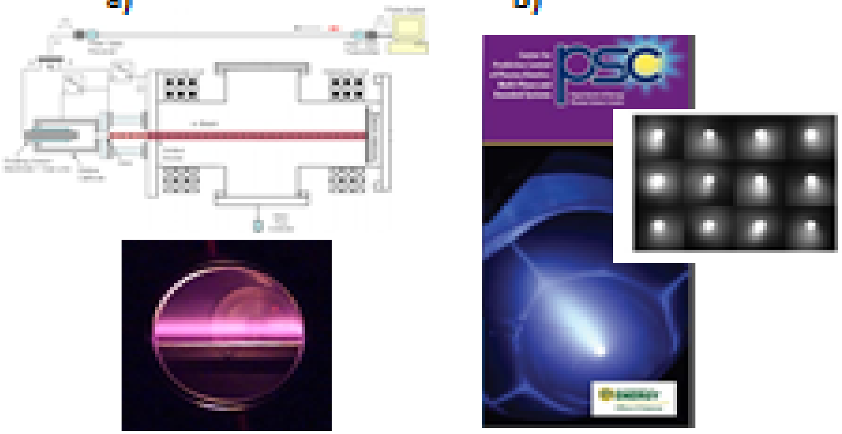
a) b)



- Sputtering magnetron discharge: (a) High power impulse magnetron (HiPIMS); (b) Plasma non-uniformity rotating in E × B direction (DC Magnetron). *A. Anders et al., IEEE TPS to appear in 2014, APL 2013*

- Functionalization of nanomaterials by magnetically filtered cold plasmas

a) b)

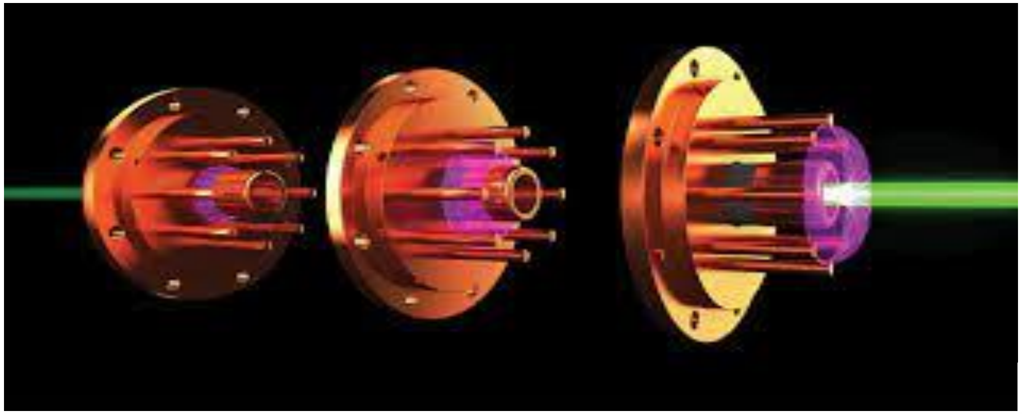


- (a) NRL Electron-beam plasma source for functionalization of graphene. *Baraket, Walton et al. 2014*; (b)PPPL DC-RF plasma-beam system and rotating spoke instability. *Raitses et al., DOE PSC meeting 2012*

- Need understanding of relevant plasma instabilities and plasma-surface interactions at nanoscale level to control quality of synthesis and functionalization processes and nanomaterials.

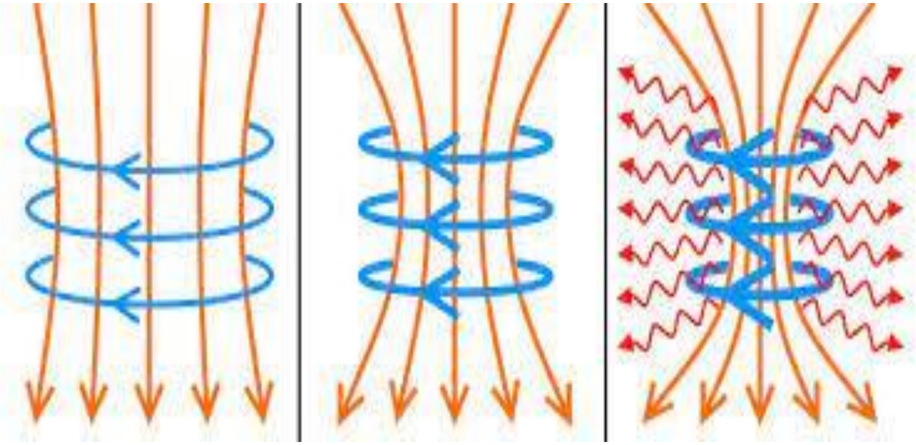
Pinch, Confinement & Focus Plasma

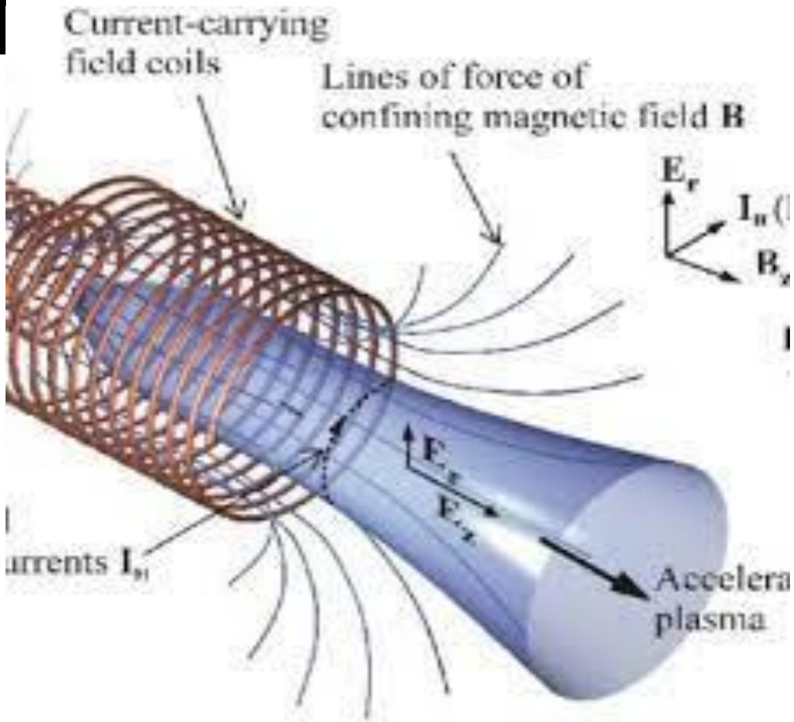
Pinch



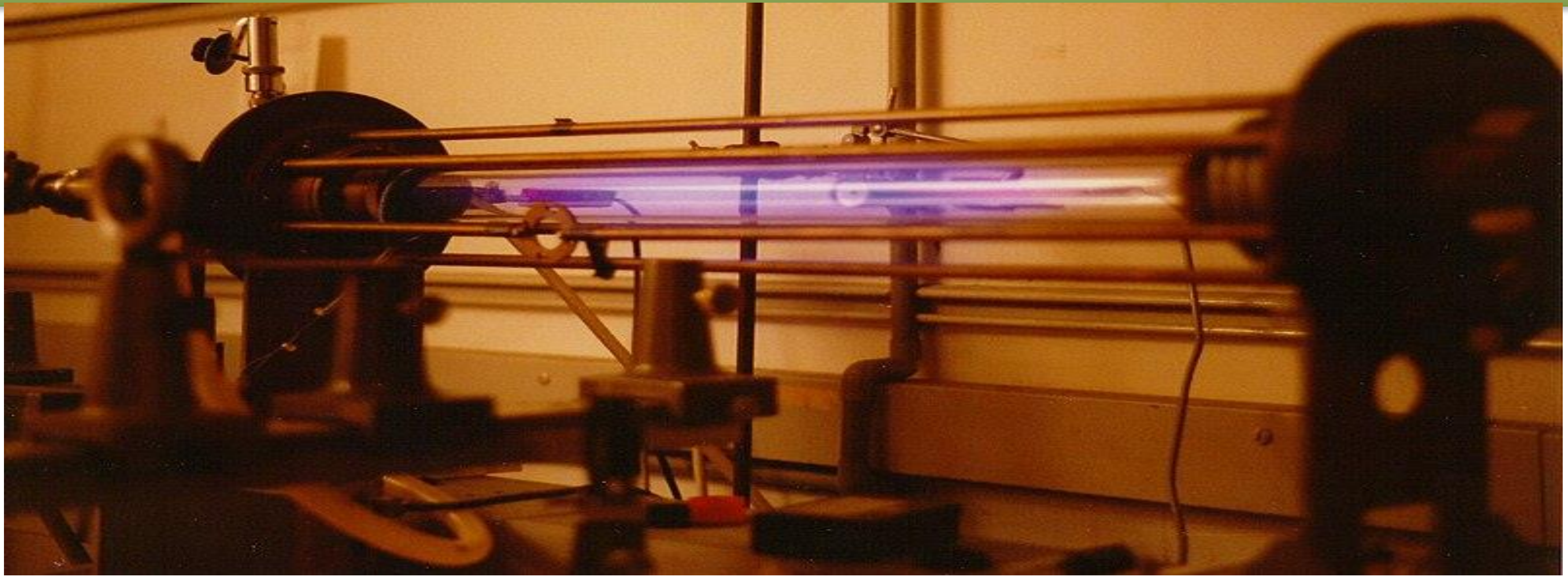
Theta -Pinch

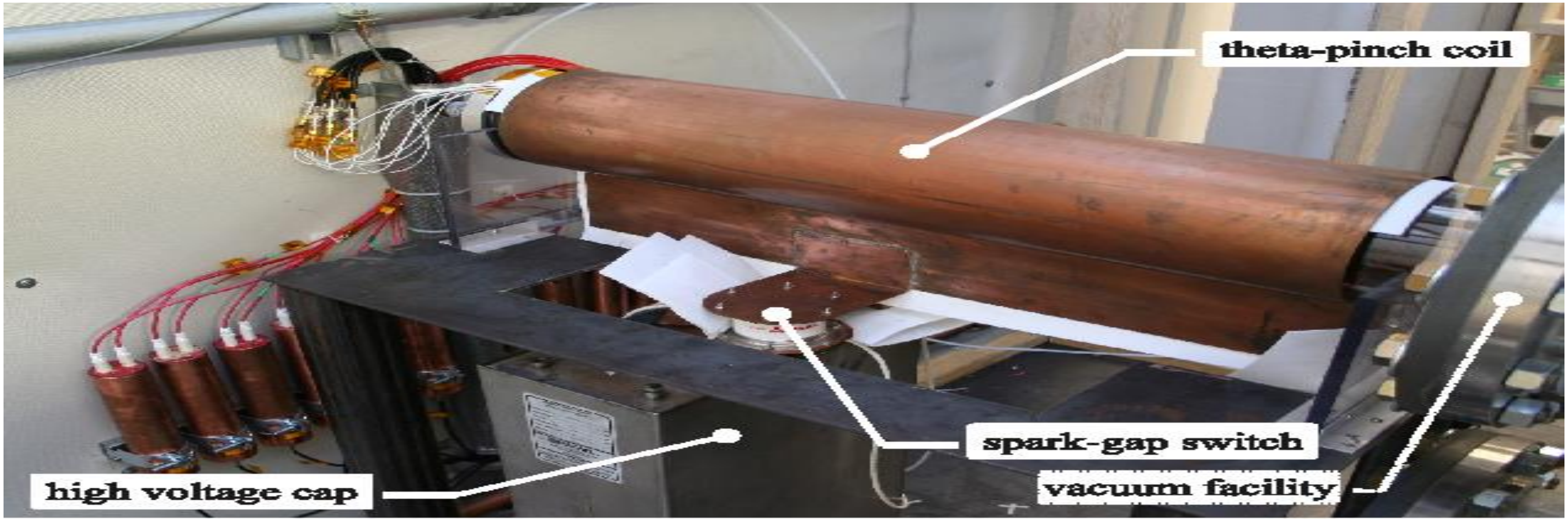
Z -Pinch





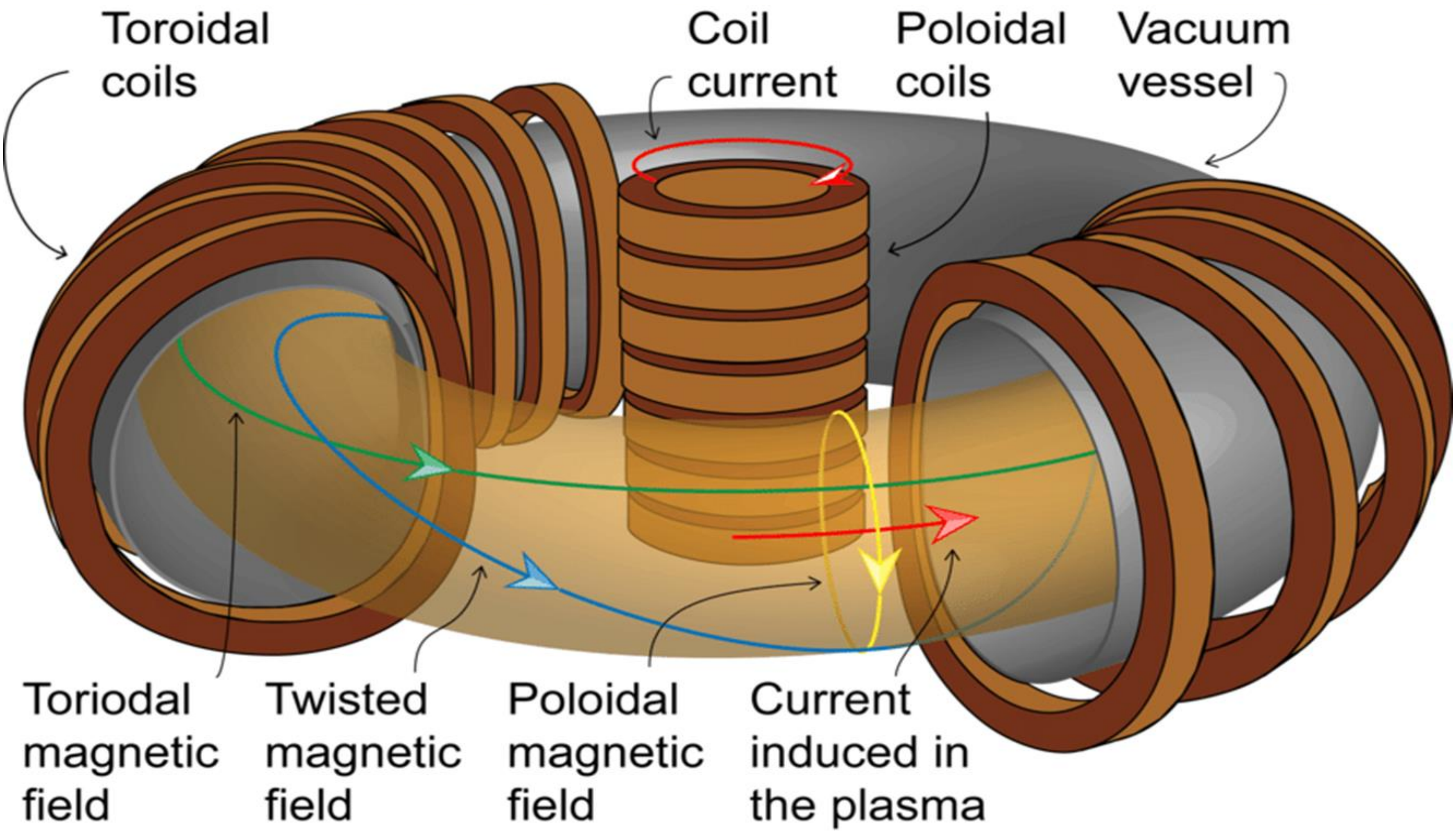
Pinch, Confinement & Focus Plasma



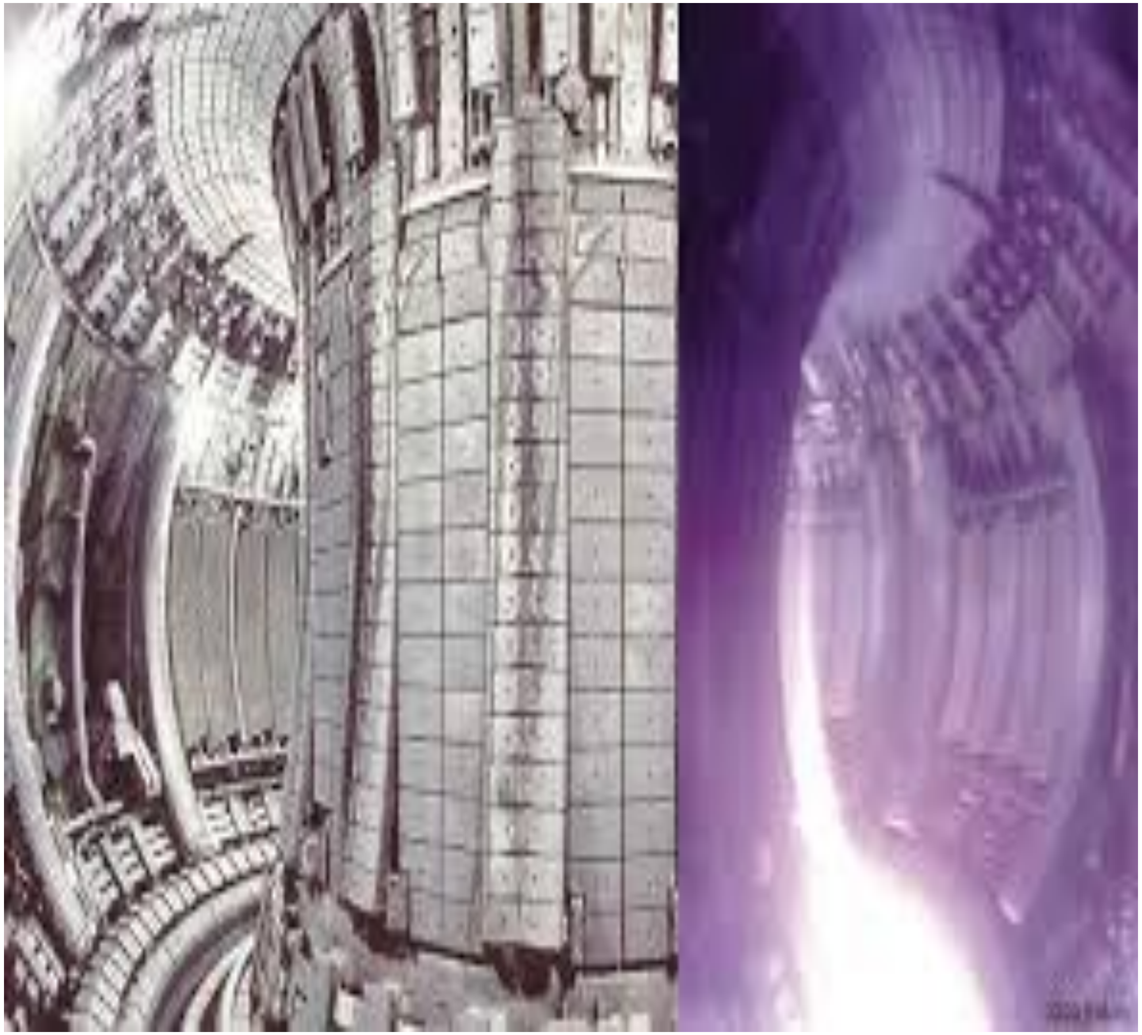


Pinch, Confinement & Focus Plasma

Plasma Confinement

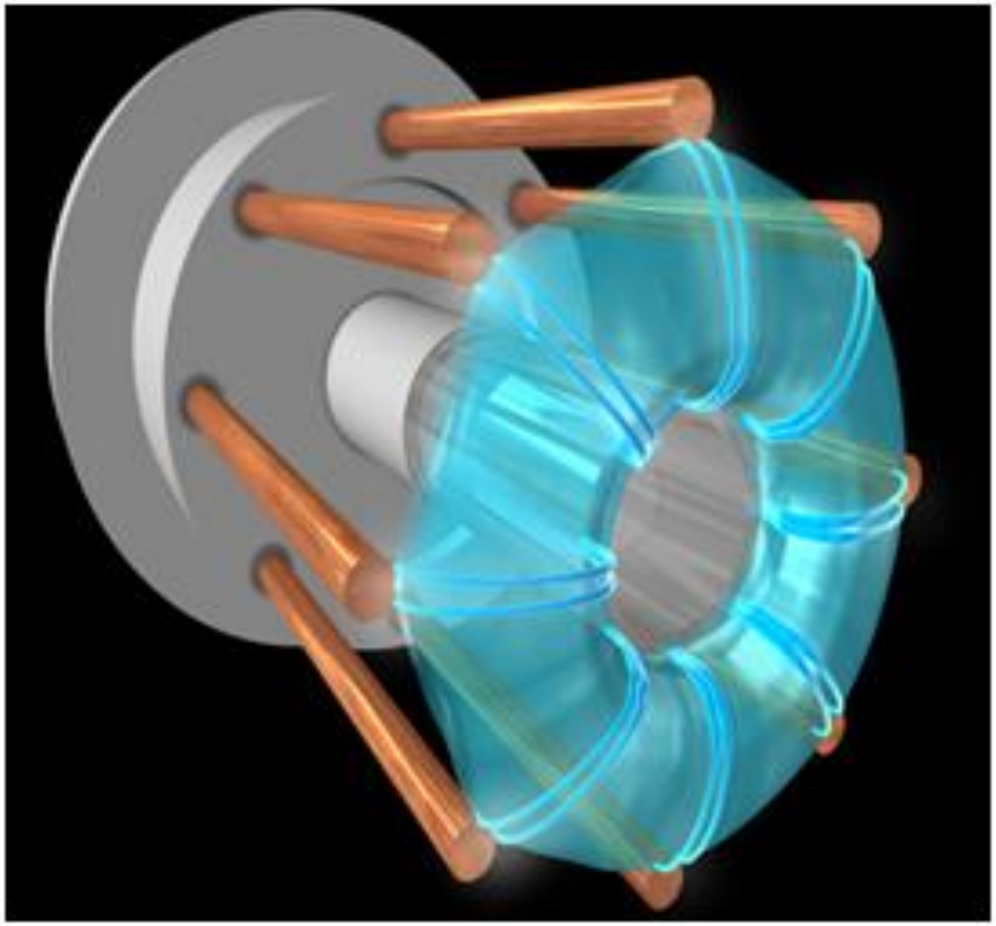


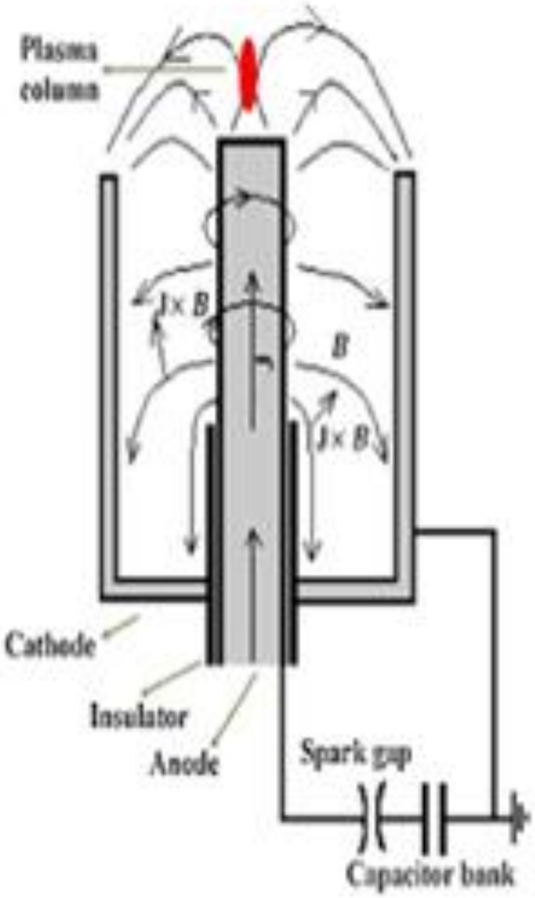
Pinch, Confinement & Focus Plasma



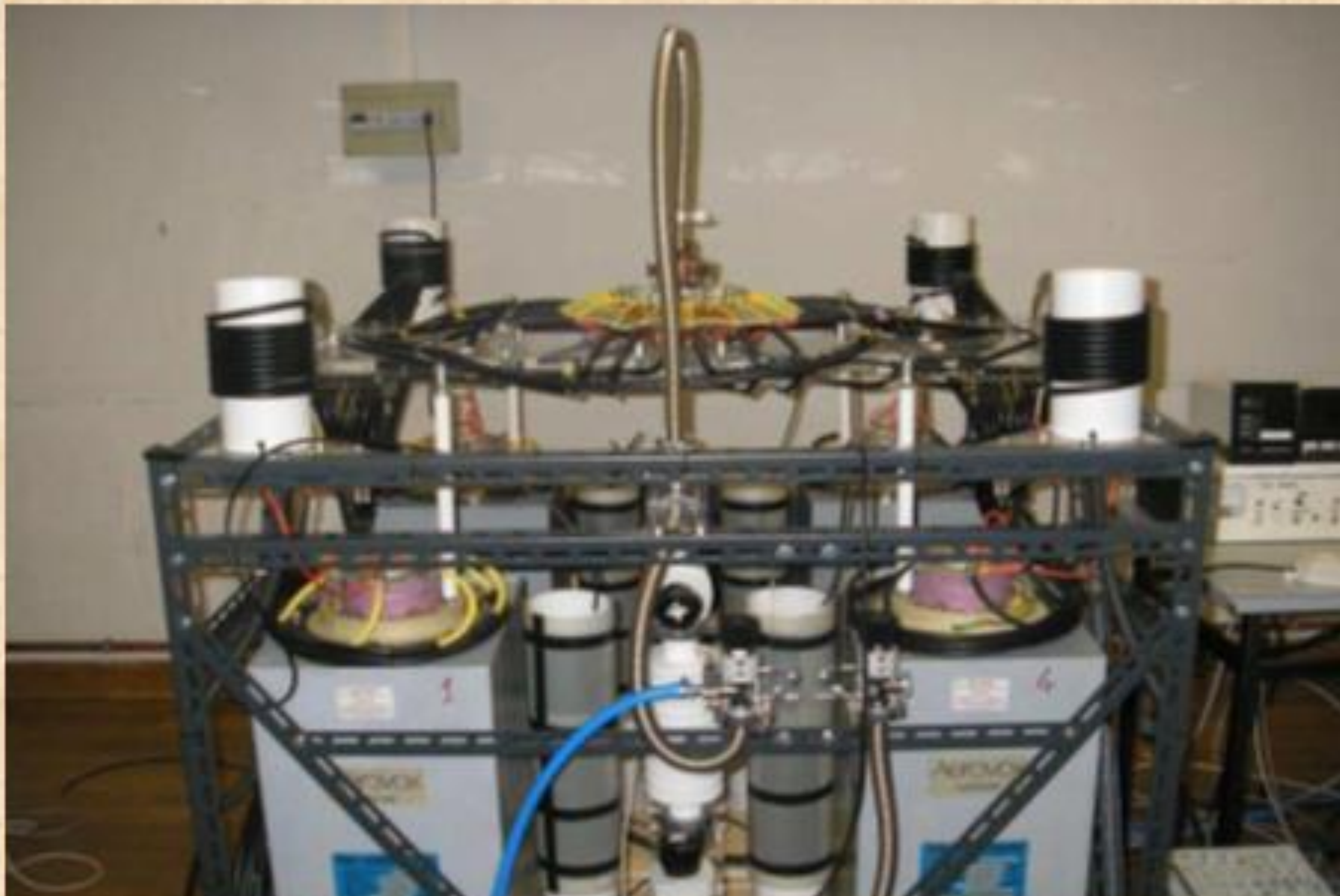
Pinch, Confinement & Focus Plasma

Plasma Focus



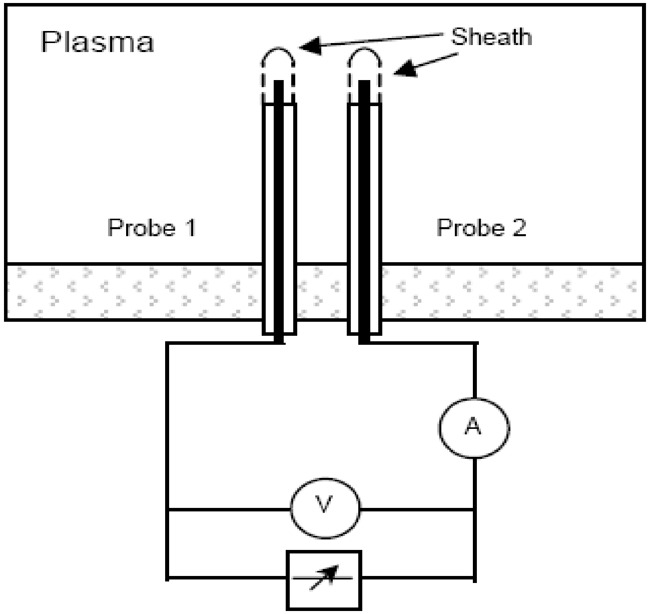


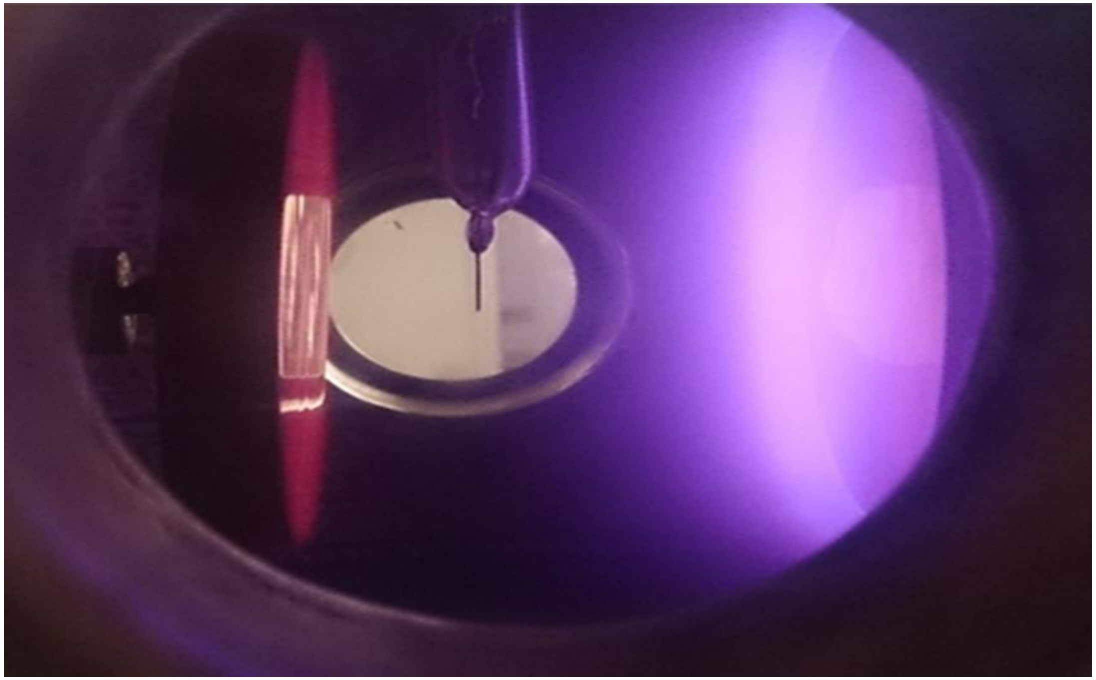
Pinch, Confinement & Focus Plasma



DPF "Bora" fully assembled

Diagnostic Tools





$$kT_e = eV_s / 2 \quad (1)$$

$$n = I_s / eA\,(kT_e / 2m_i)^{1/2} \quad (2)$$

Where: V_s is the saturation voltage,

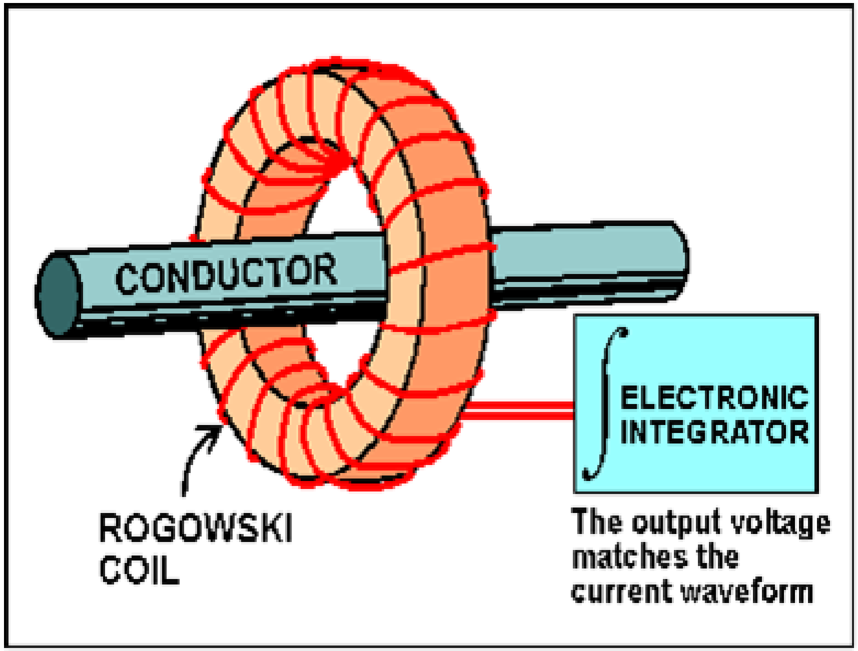
I_s is the saturation current

m_i is the mass of helium ion.

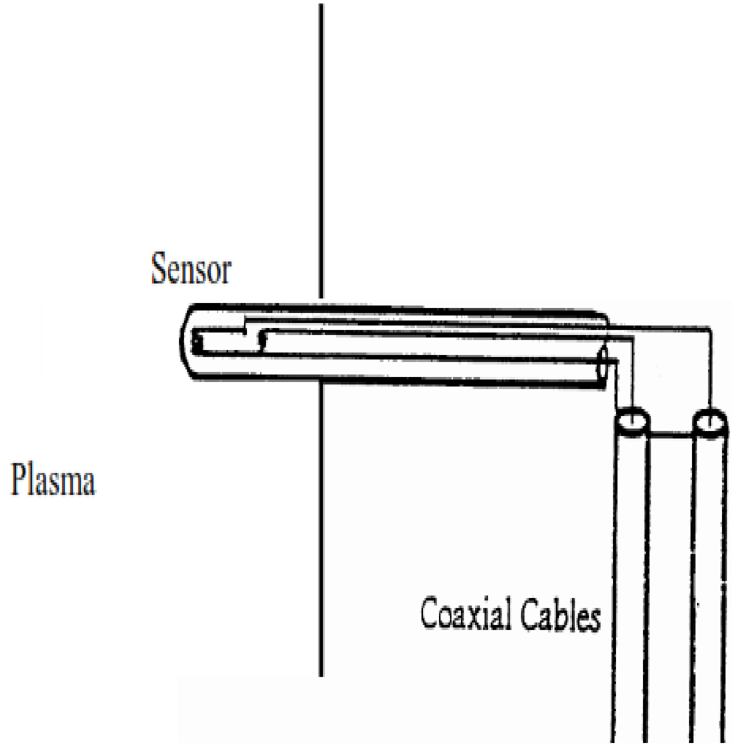
A is the area of the probe.

e is the electron charge

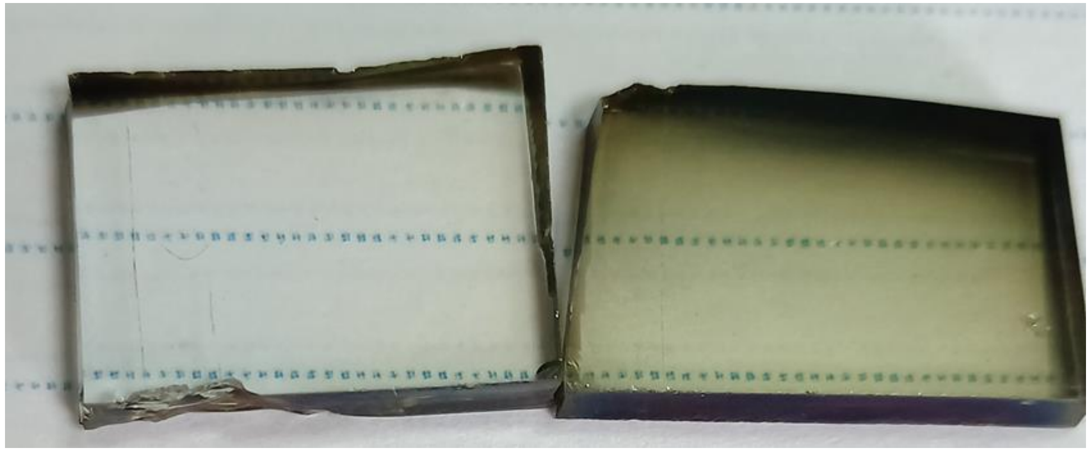
Diagnostic Tools



$$V_1 = \frac{nA\mu_o}{RC} I$$



B = $\int nAVdt$



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THANK YOU