Gallium Nitride: Dry Etching and Wet Etching

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Comisión Nacional de Energía Atómica

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Outline

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Etching necessity

Etching is very important for defining devices. Some classical examples are:

- Etching for further formation of ohmic contacts
- Mesa-etch isolation

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Etching parameters

Some etching aspects are specially important in semiconductor production...
Some of them are:

- Etch rate
- Selectivity with PHR and dielectrics
- Isotropy control
- Repeatibility
- Cost
- Equipment required

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	Dry Etching	Wet etching
Etch rate	Lower	Higher
Isotropy control	Very good	Poor
Repeatability	Excellent	Good
Cost	Higher (gases + electricity)	Lower
Equipment required	Complex (Vaccuum, MFCs)	Very simple
Sample damage	Higher	Lower

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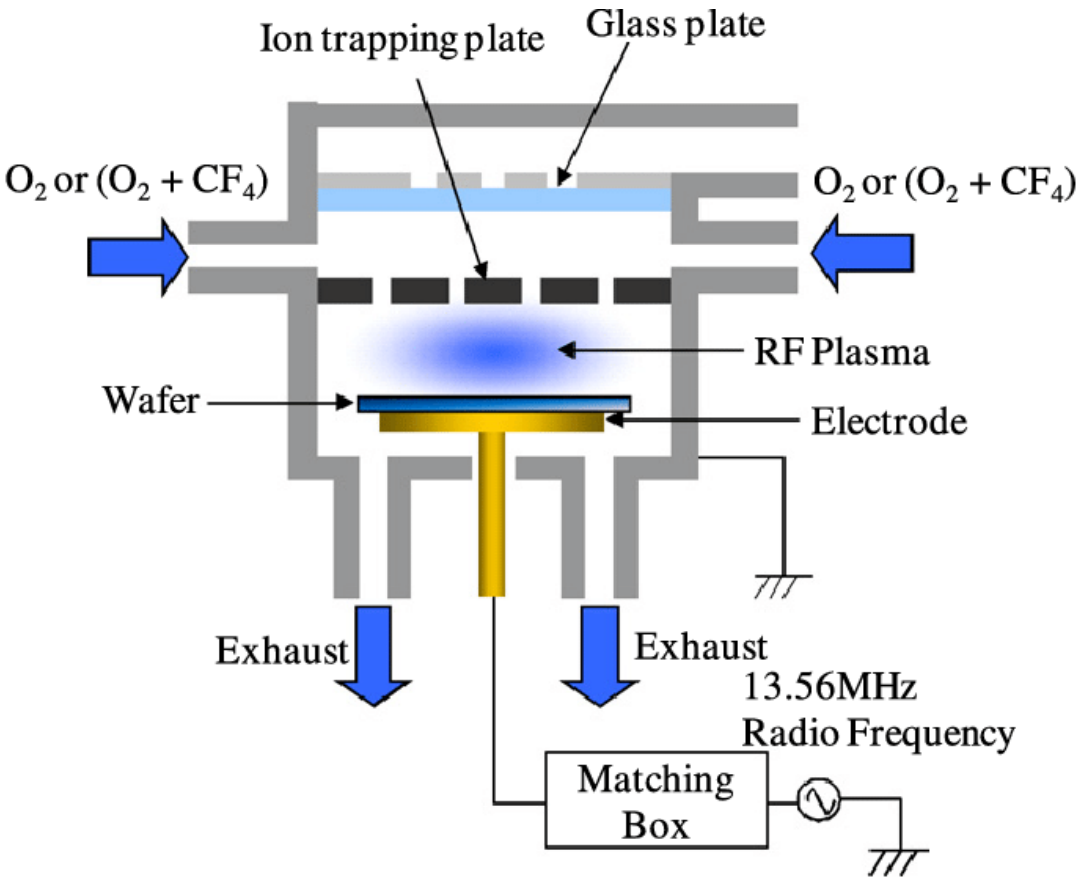
RIE - Reactive ion etching

- Combination of Phsyical and chemical etching
- Physical = non-reactive ions
- Chemical = reactive ions
- Mostly using *Cl* based gases por GaN



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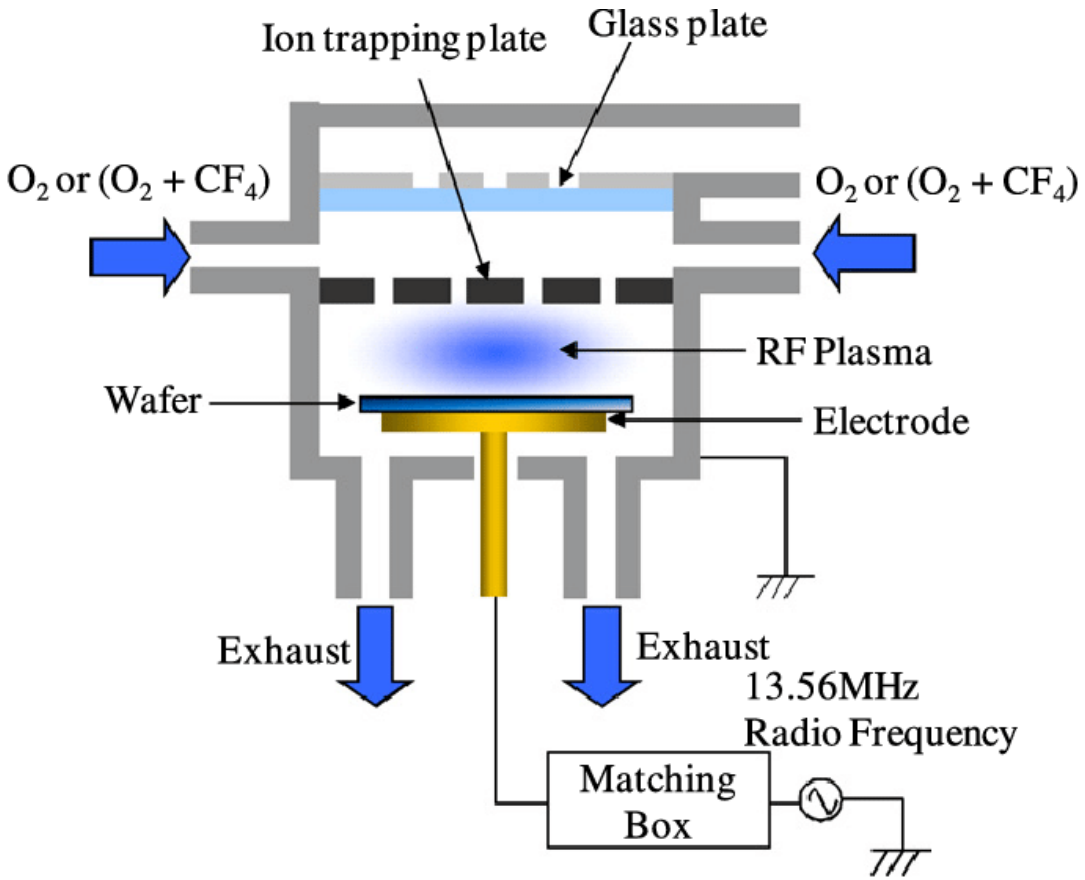

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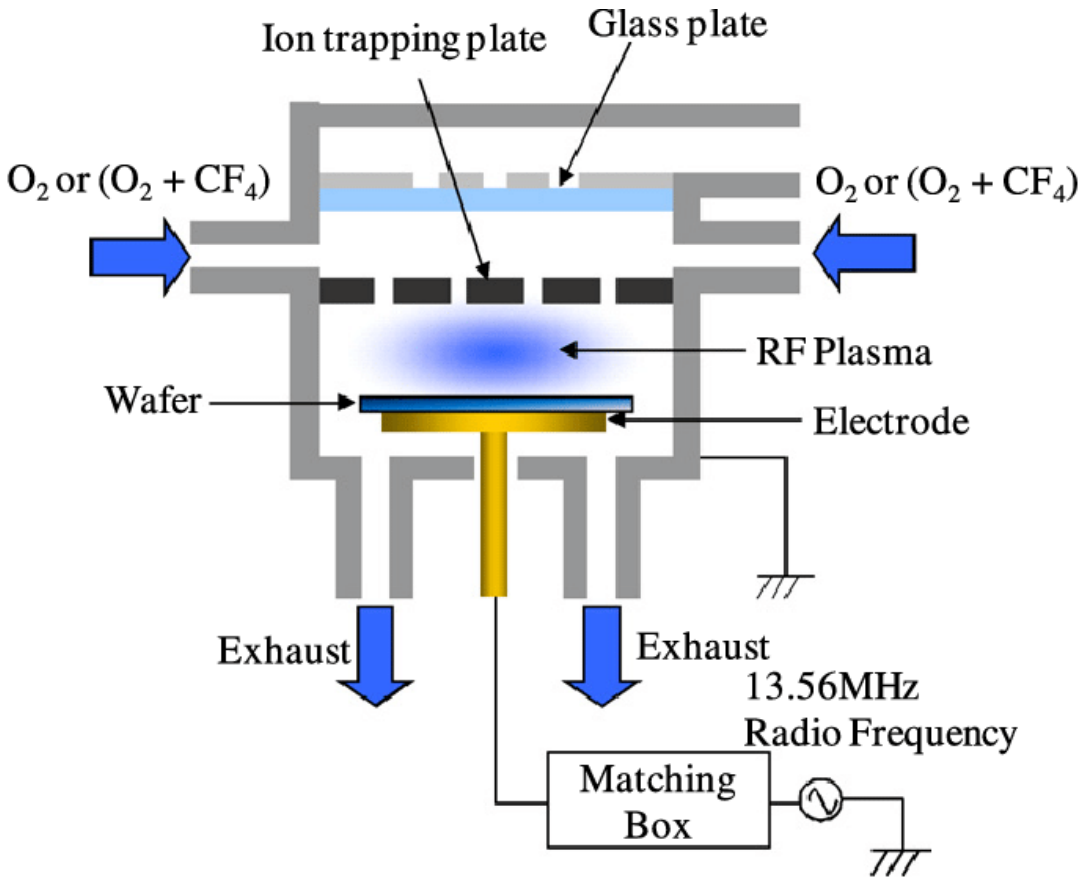

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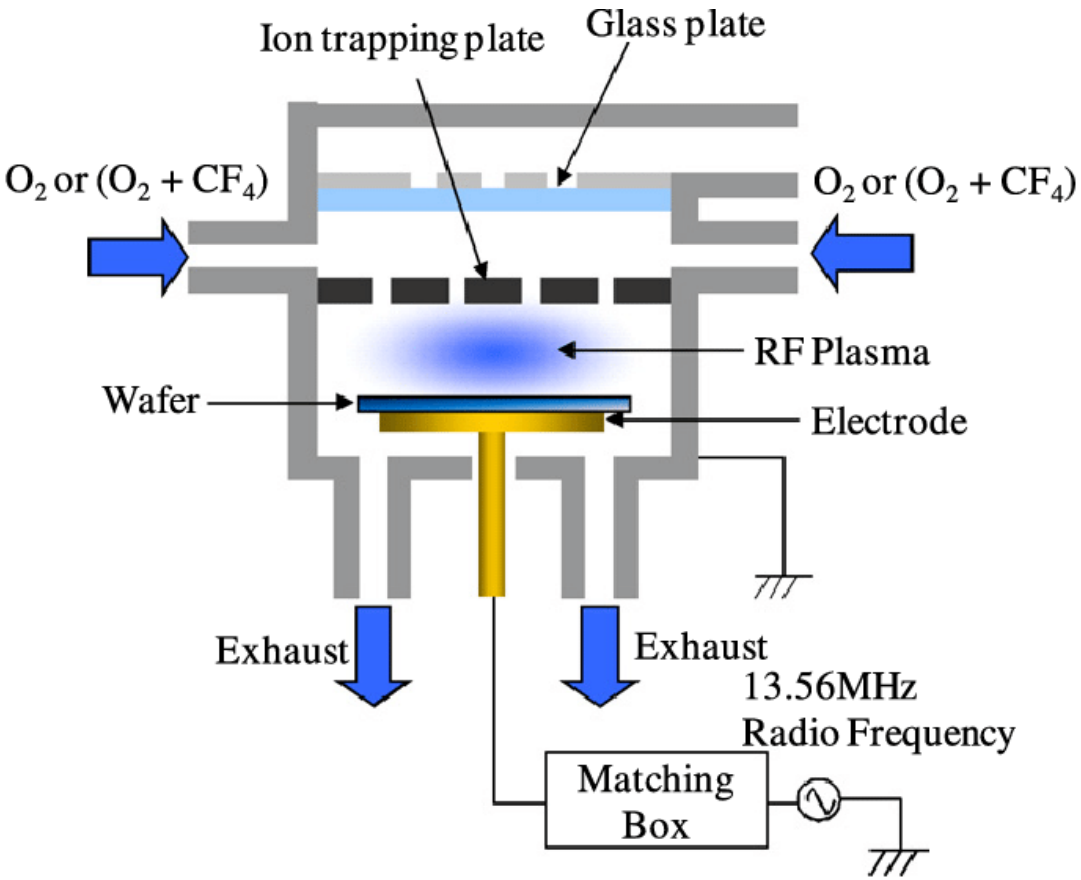

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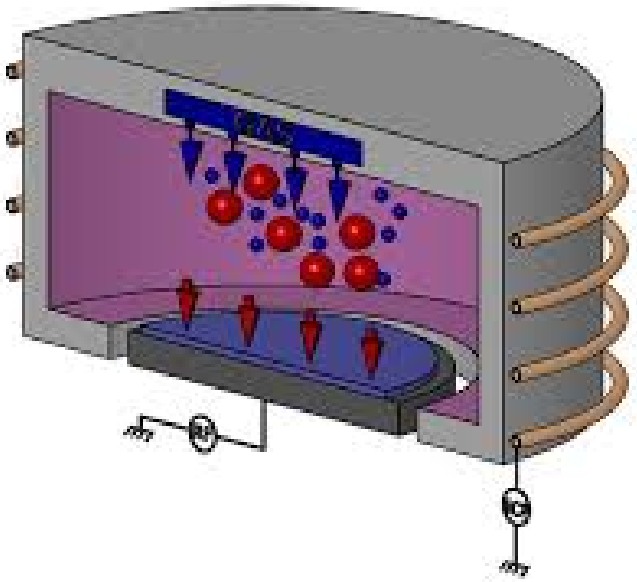
ICP RIE - Inductevely Coupled Plasma

- Similar to RIE, but magnetic field generated plasma
- Much denser plasma and consequently higher etch rate
- Tends to be more isotropic
- Possible to combinate with common RIE in same process



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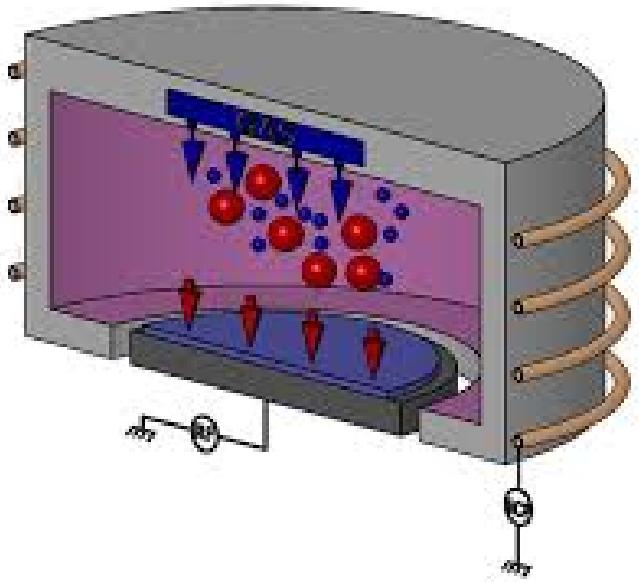

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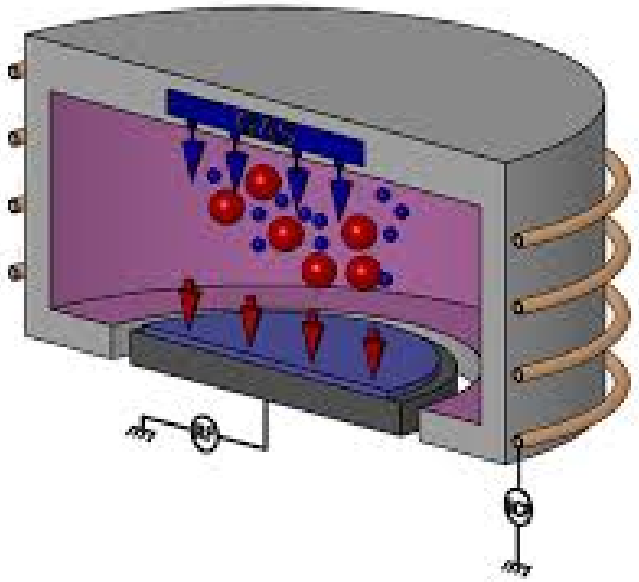

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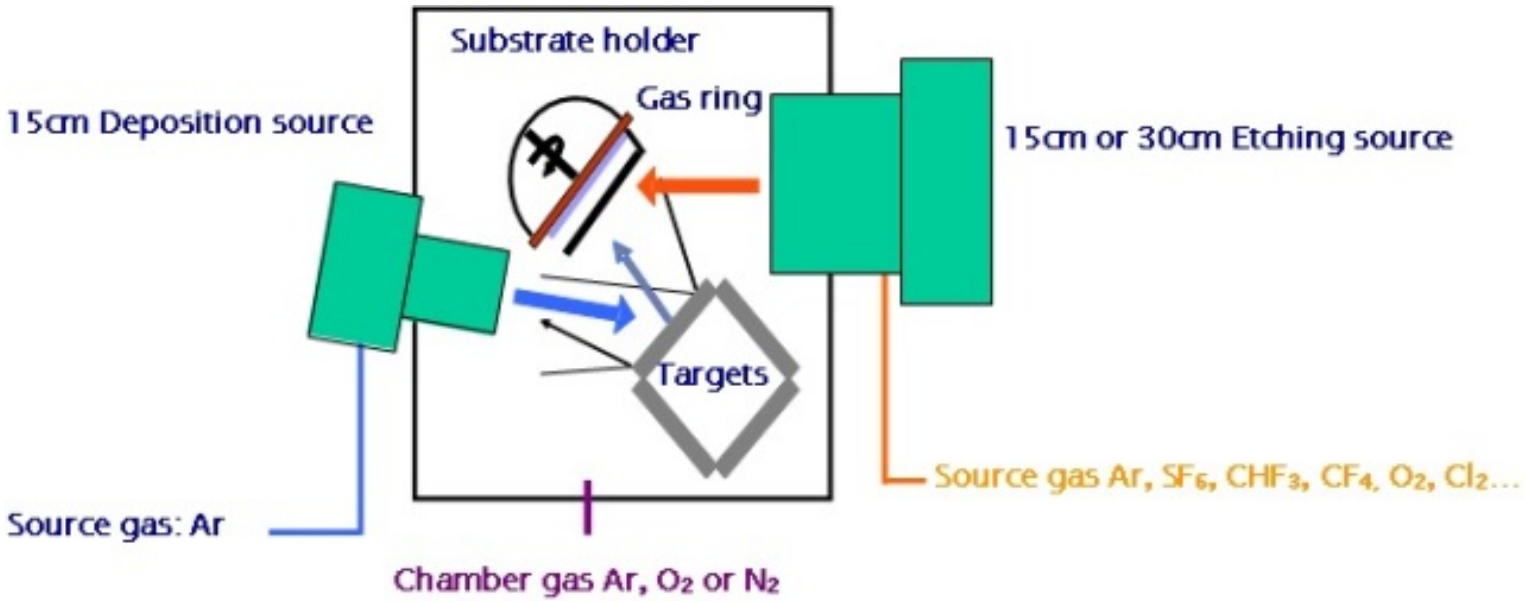
RIBE - Reactive Ion Beam Etching

Uses an Ion Beam instead of plasma+gases



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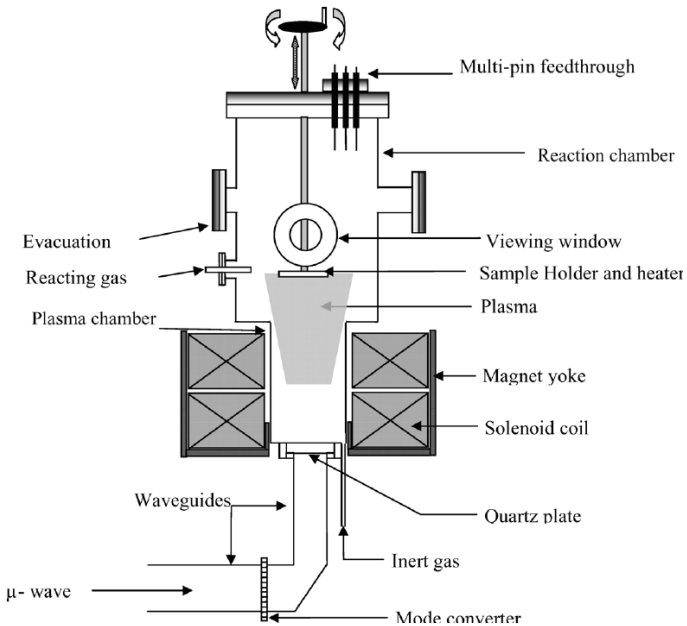
ECR - Electron Cyclotron Resonance Plasma

- Ultra-Low Pressure and Highest Density Plasma
- Plasma distribution and height control
- Ion and radical control
- Temperature control



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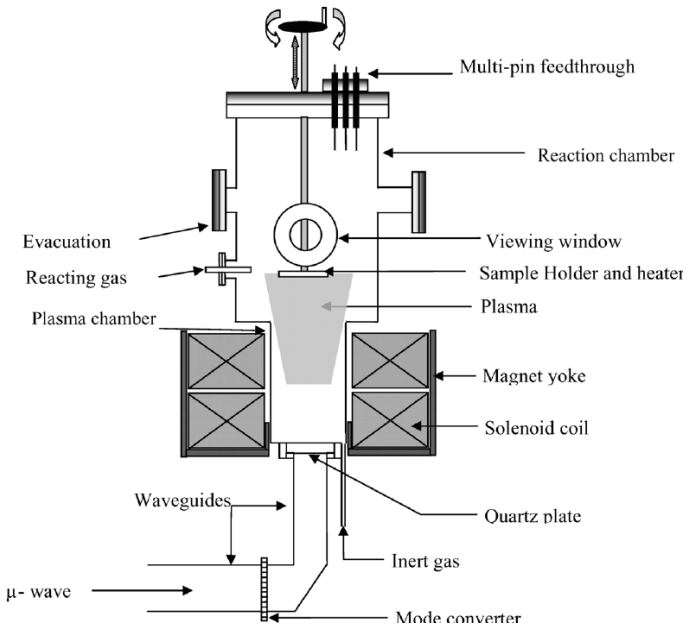

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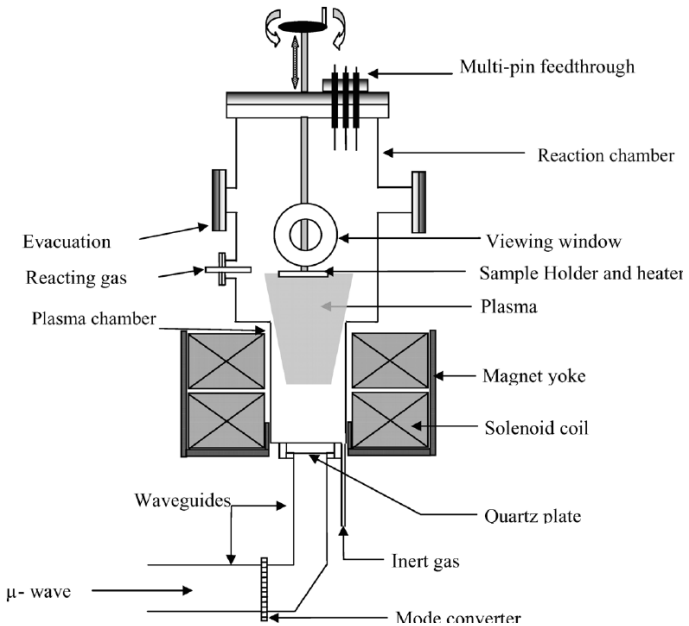

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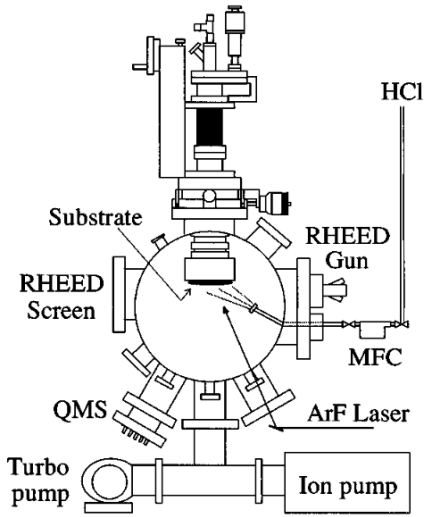
Photo Assisted Dry Etching

- Simulataneous exposure of reactive gas and UV laser radiation
- Laser interaction with the surface, bulk and reactants leads to bondbreaking and desortion of reactant.
- Promising for achieveing damage-free etching
- For GaN, HCl with ArF (193nm) laser is typically used



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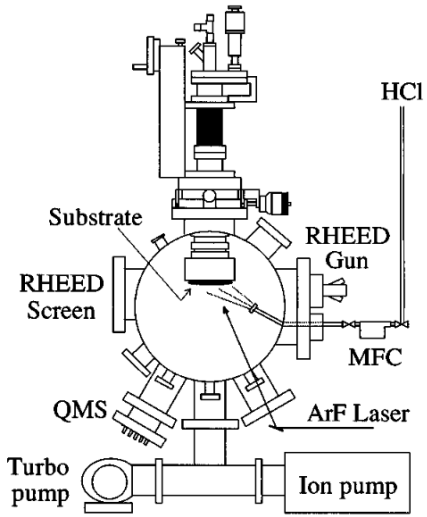

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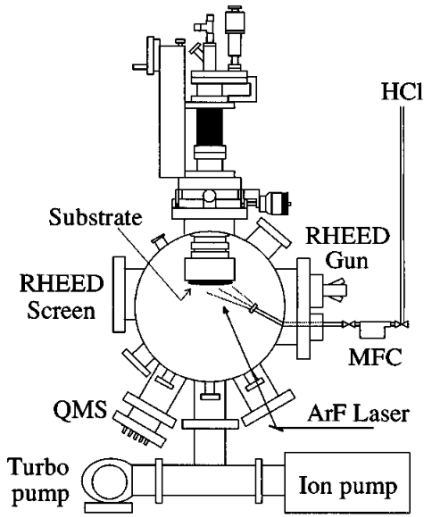

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Wet chemical etching with KOH

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- Very smooth surface termination

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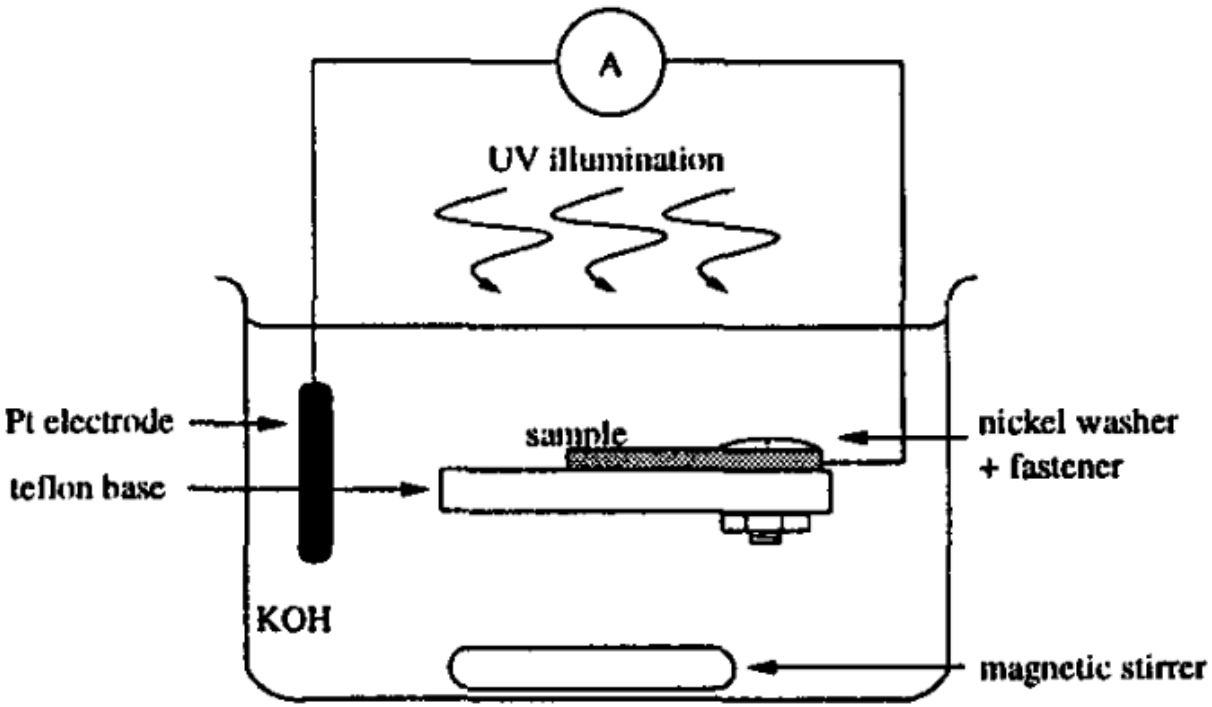
UV+KOH

- Wet chemical etching
- Xenon lamp for UV illumination and KOH solution
- UV is used as cathalyzer



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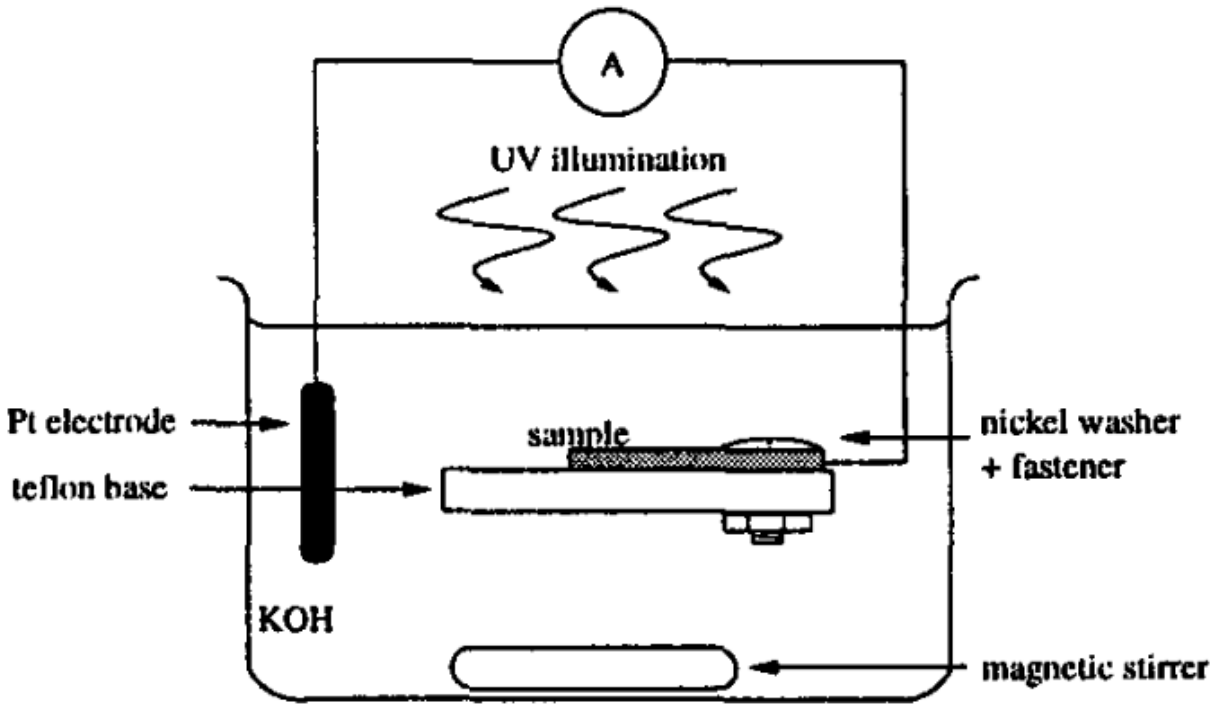

Summary

- Definition of important etching parameters will be stated.
- General aspects of dry and wetching will be explained.
- Specific Dry and Wet Etching for Gan techniques will be reviewed, focusing on the ones available at CNEA CAC DMNT. More wet etch techniques are to be studied.

- Outlook
  - Get consistent data for comparison
  - Presentation of the informatino and conclussions

For Further Reading I

J. Lee et al.
Dry Etching of GaN and Related Materials: Comparison of Techniques.
IEEE Journal of Selected Topics in Quantum Electronics, 1998.

B. Kinder and T. Tansley.
A Comparative Study of Photoenhanced Wet Chemical Etching and Reactive Ion Etching of GaN Epilayers Grown on Various Substrates
Conference on Optoelectronic and Microelectronic Materials and Devices. Proceedings (Cat. No.98EX140), 1999.