# Atmospheric Pressure Plasma Thin Film Deposition

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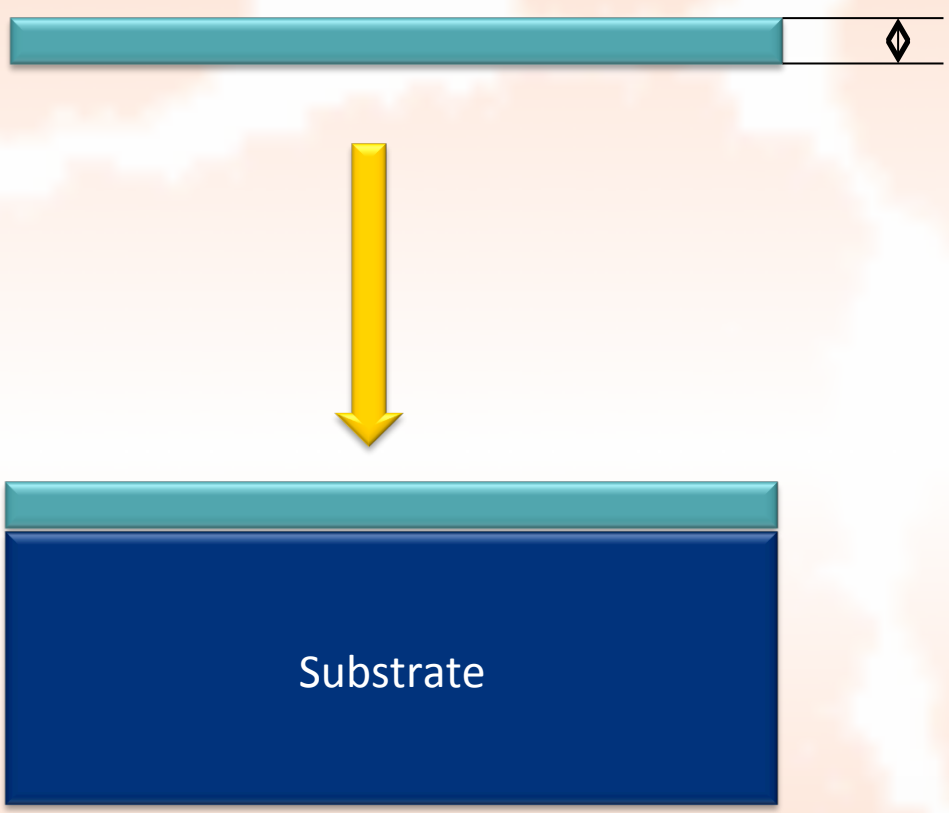
- Introduction
- Atmospheric Pressure Plasma Thin Film Deposition
- Research Method
- Summary

# Introduction

- Thin Film Deposition
- Classify thin film deposition
- Application of Thin Film Depostition

# Thin Film Deposition



# Thin Film Deposition

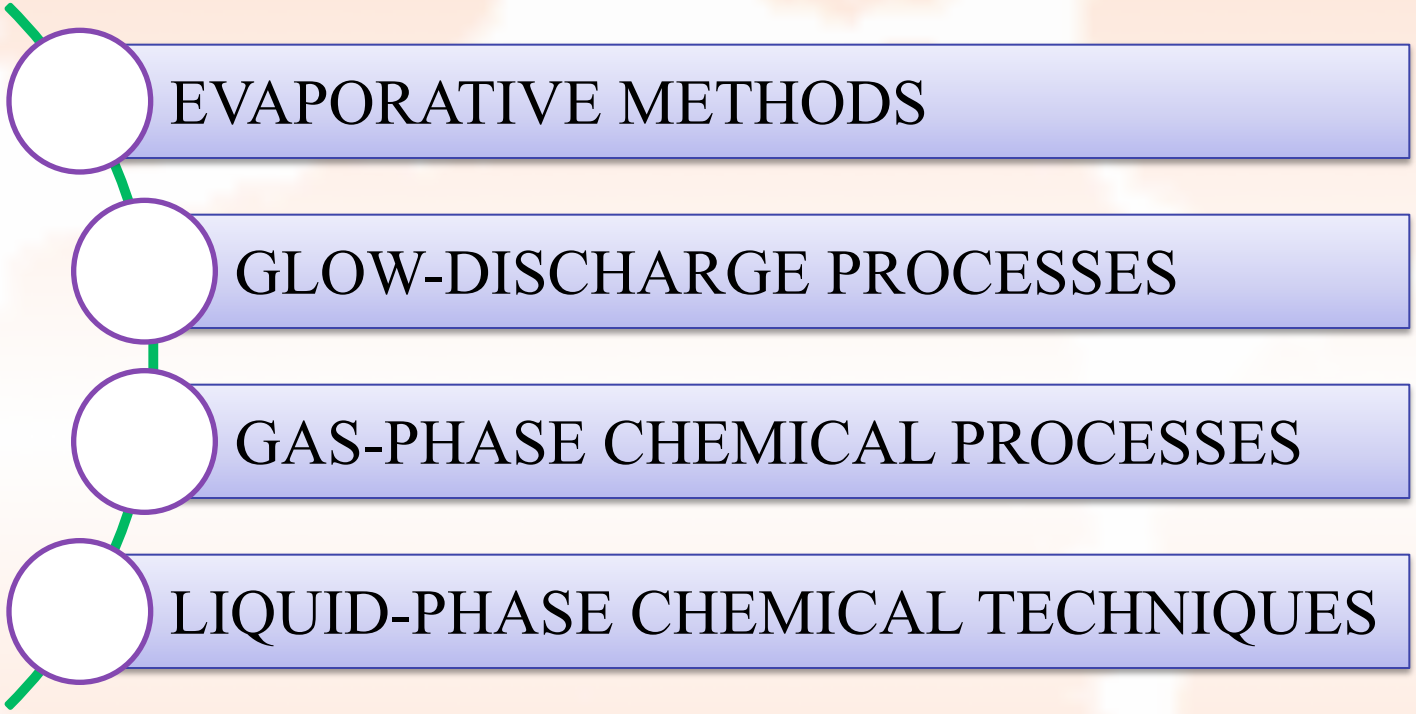
**PVD : Physical Vapor Depostion**

- Thermal evaporation
- DC or RF sputtering
- Ion Beam sputtering
- Pulsed Laser Depostion
- Molecular beam epitaxy

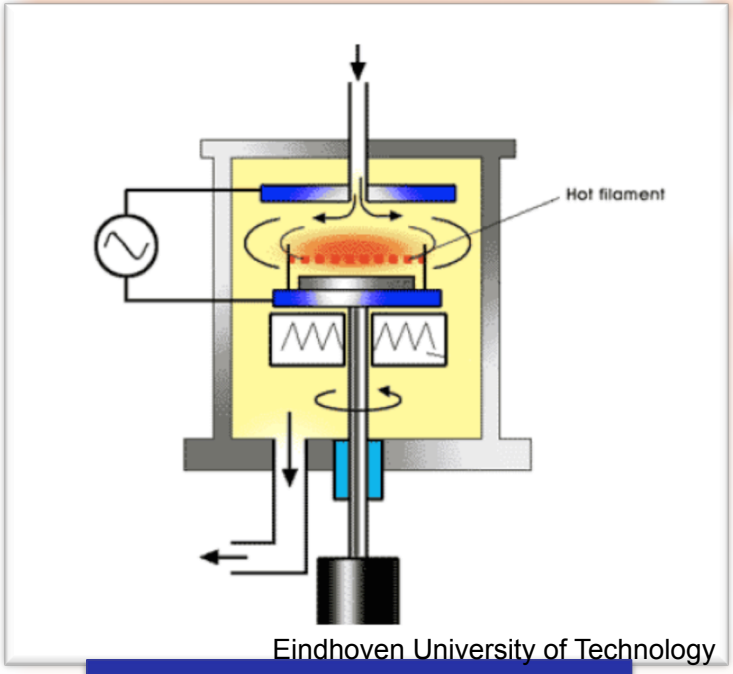
**CVD : Chemical Vapor Deposition**

- Thermal CVD
- Low pressure CVD
- Plasma enhanced CVD
- Metal-organic CVD

# Thin Film Deposition Technology

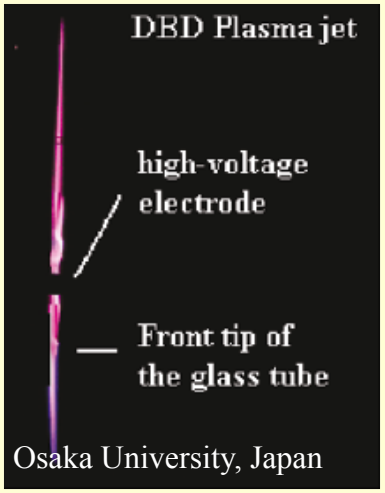


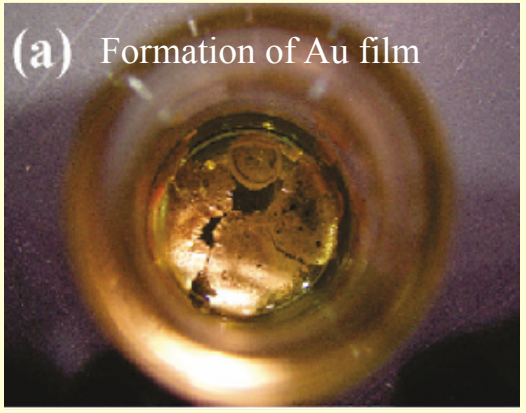
# Plasma Processes in Thin Film Deposition




Eindhoven University of Technology

Plasma Enhanced CVD




Plasma reduction

| | | | | | |
|---|---|---|---|---|---|
| Plasma-enhanced CVD | Plasma oxidation | Plasma anodization | Plasma polymerization | Plasma nitridation | Plasma reduction |
| | | Microwave ECR plasma CVD | Cathodic arc deposition | | |

# Application of Thin Film Deposition

Electronic Components.

Electronic Displays

Optical Coatings.

Magnetic Films for Data Storage

Optical Data Storage Devices

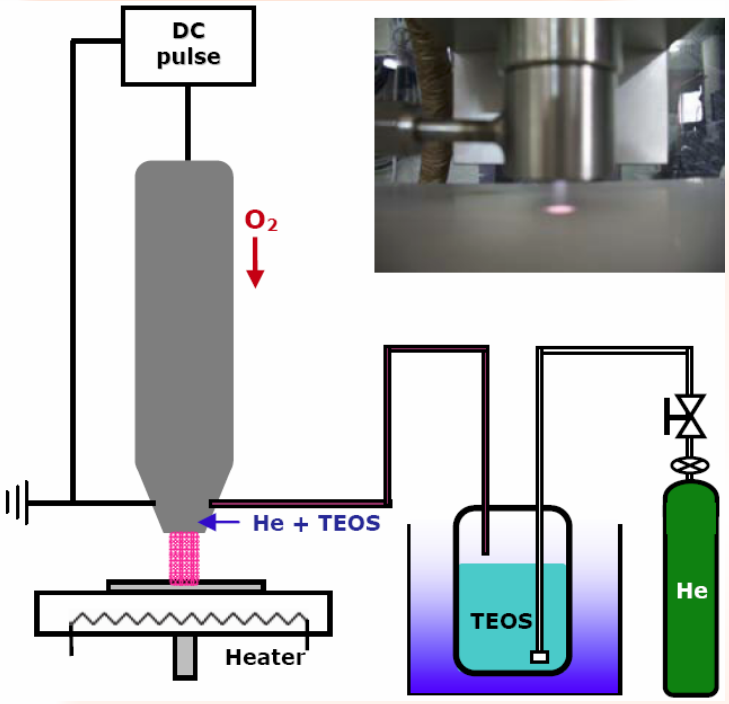
Antistatic Coatings

Hard Surface Coatings

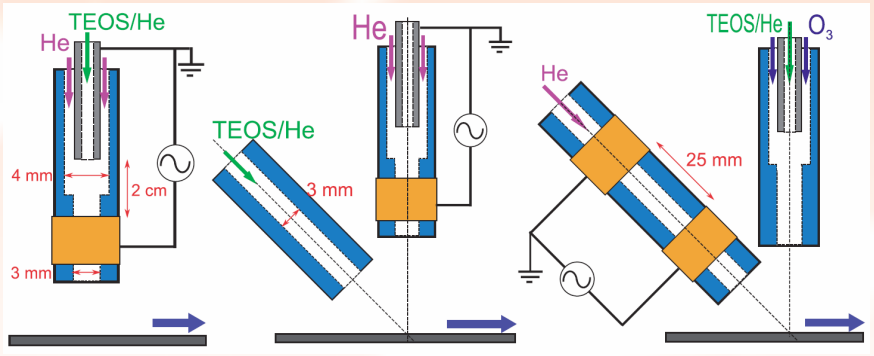
# Atmospheric Pressure Plasma Thin Film Deposition♪

- Advantage
- Disadvantage
- Application of APPTFP♪

# Atmospheric Pressure Plasma Thin Film Deposition



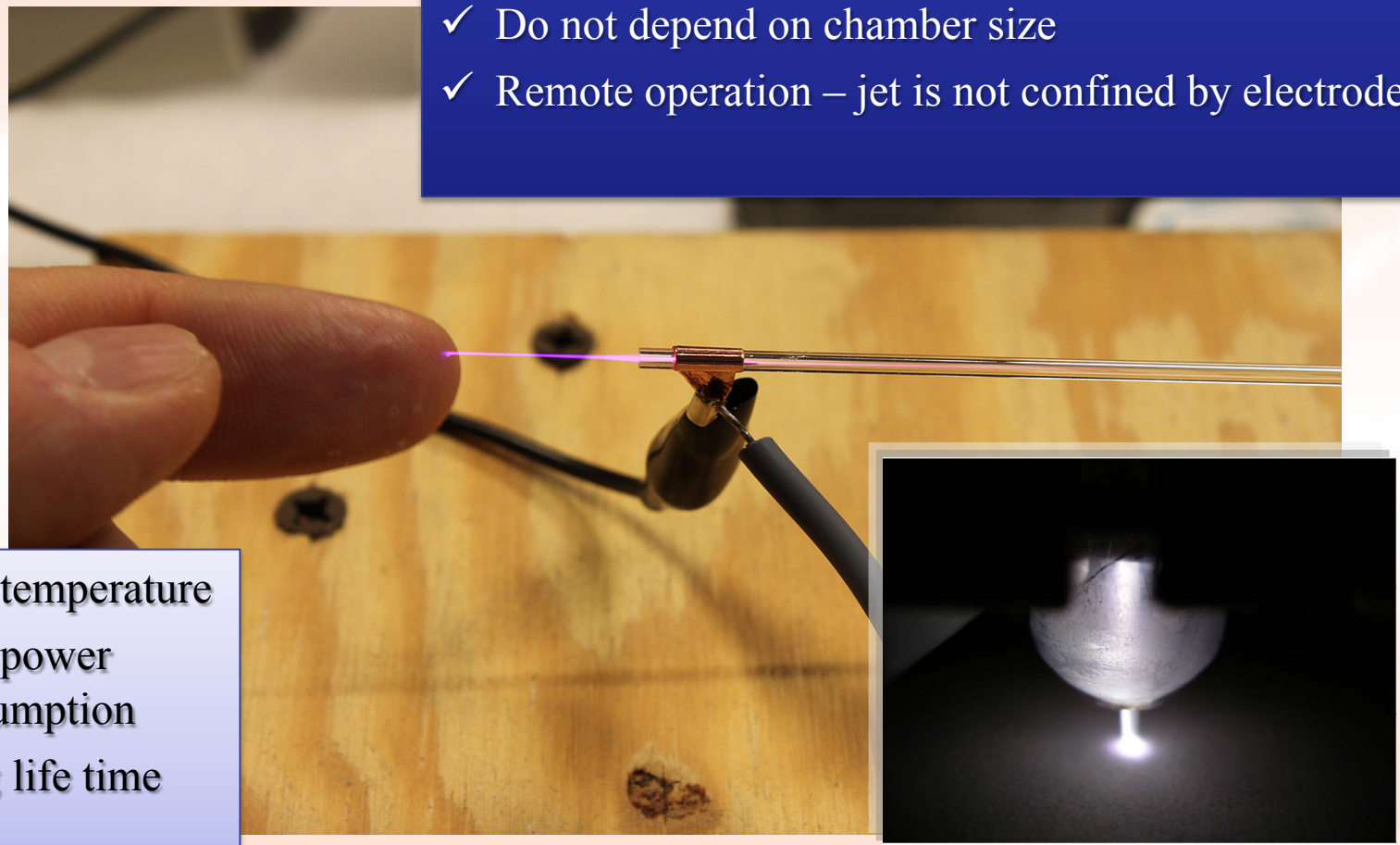

M. H. Han, et al




Y. Ito, K. Urabe, N. Takano, and K. Tachibana

# Advantage

- ✓ Can use DC, radio frequency or microwave driven
- ✓ Simple structure
- ✓ Do not depend on chamber size
- ✓ Remote operation – jet is not confined by electrodes

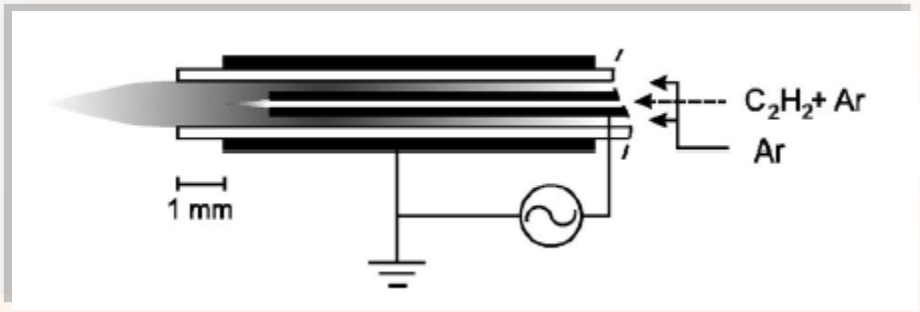


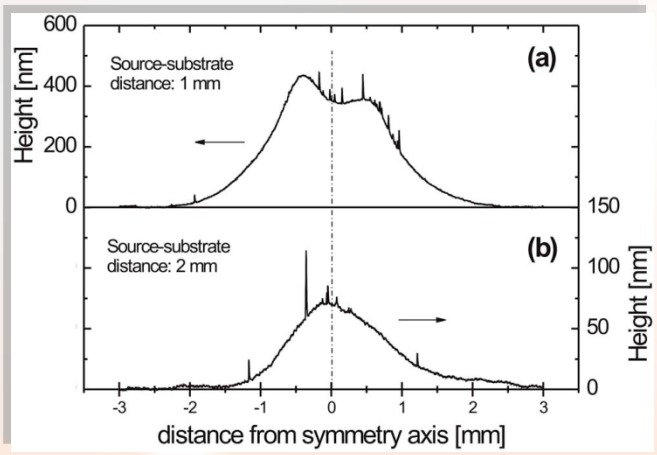
- ✓ Low temperature
- ✓ Low power consumption
- ✓ Long life time

# Disadvantage

- ✓ Miniature size
- ✓ Deposition or erosion of electrodes
- ✓ Contaminant
- ✓ Transport of reactive species is more complex than in the low pressure discharge

- ✓ Slow deposition rate
- ✓ not perfect equal height surface




M. Wolter, S. Bornholdt, M. Häckel, H. Kersten, Atmospheric pressure plasma jet for treatment of polymers, Journal of Achievements in Materials and Manufacturing Engineering 37/2 (2009) 730-734.

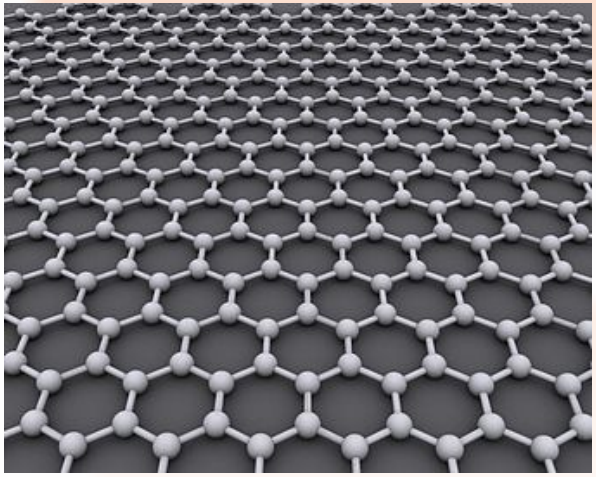
# Application of APPTFP

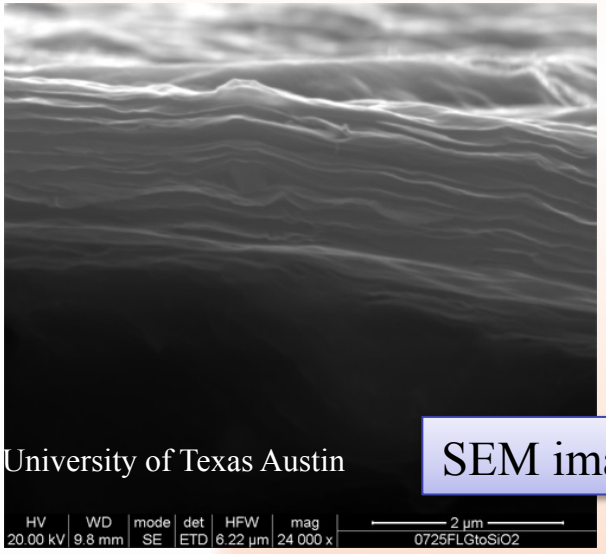
- Suitable for the treatment of temperature-sensitive materials with melting point under 150°C
- Treatment of 3D surfaces, e.g. inner walls, trenches or cavities

# Research Approach

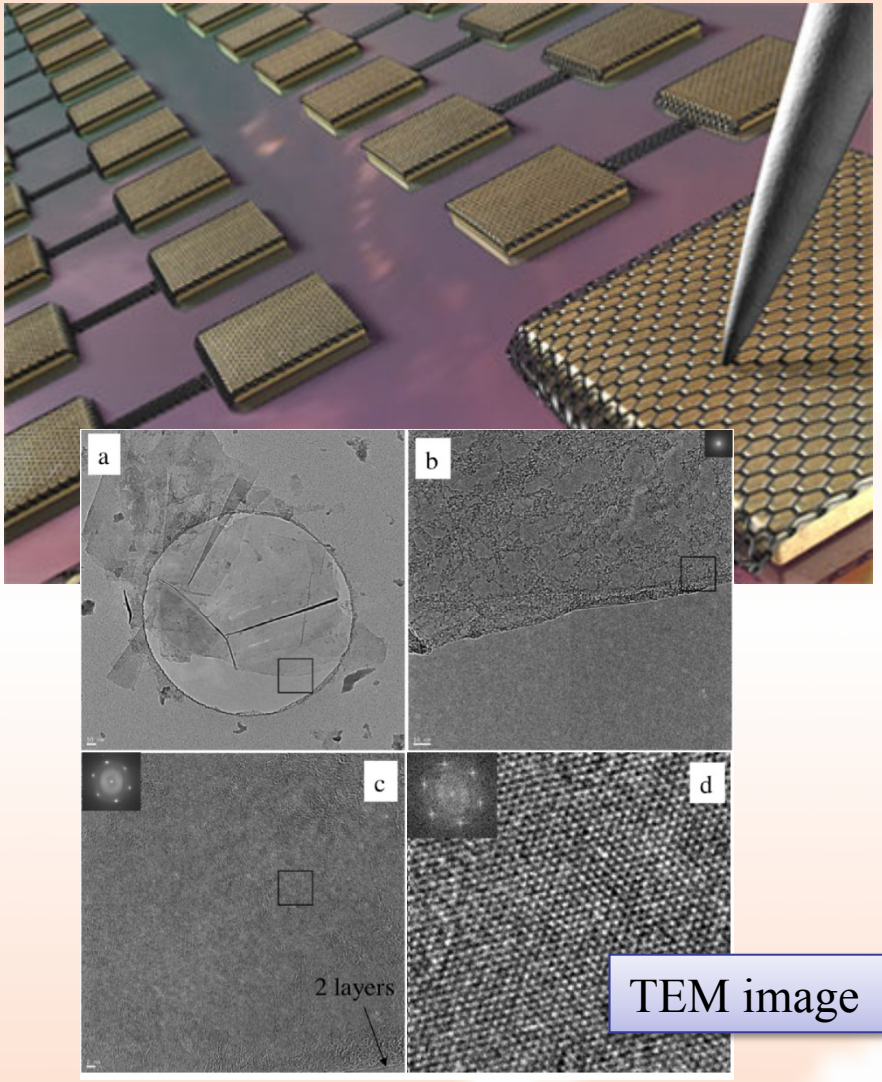
- Graphene & PMMA
- Proposal

# Graphene



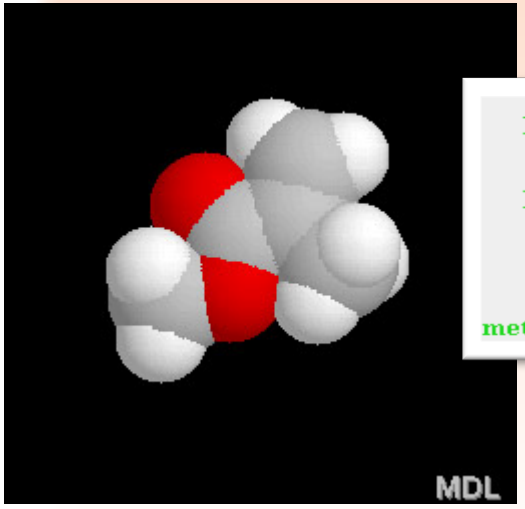


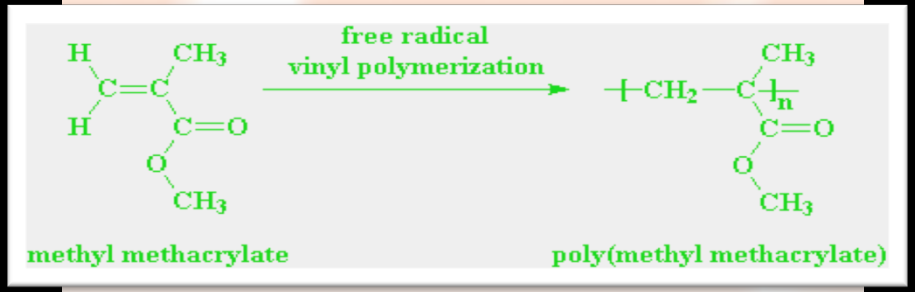

SEM image

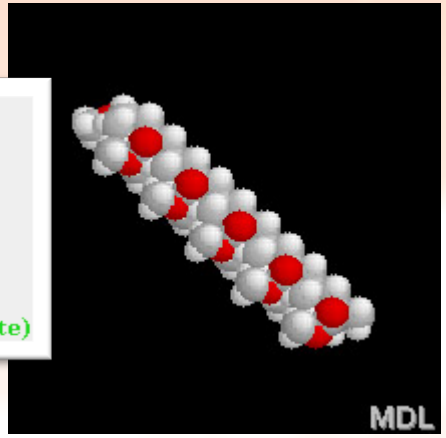


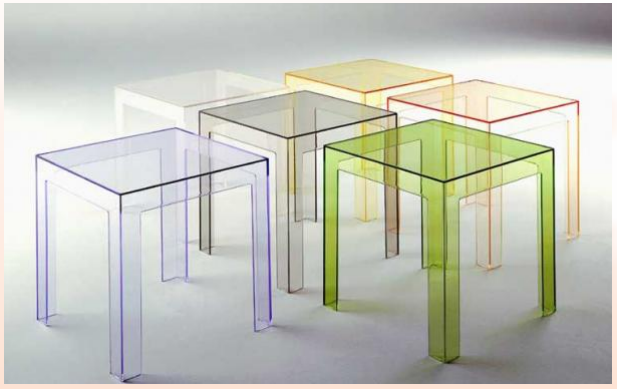

TEM image

# PMMA

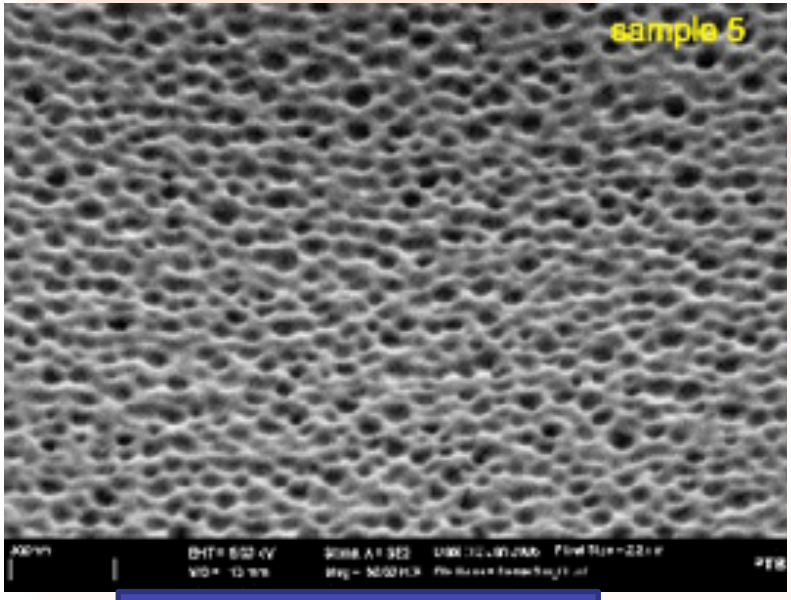

MDL


free radical
vinyl polymerization
methyl methacrylate
poly(methyl methacrylate)

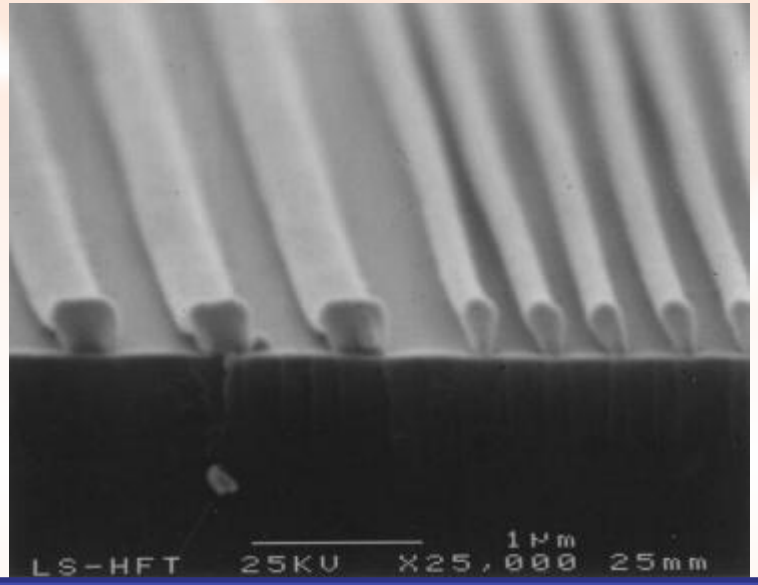

MDL



# PMMA



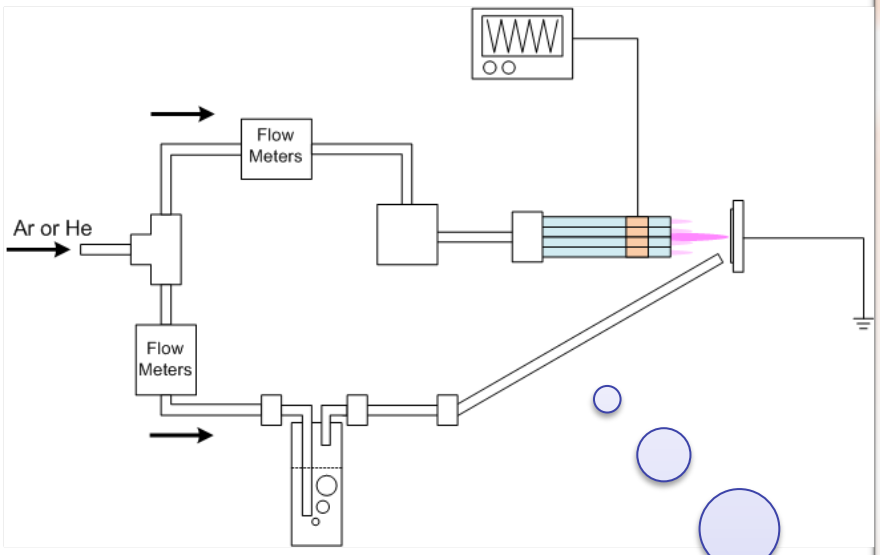

SEM image of PMMA



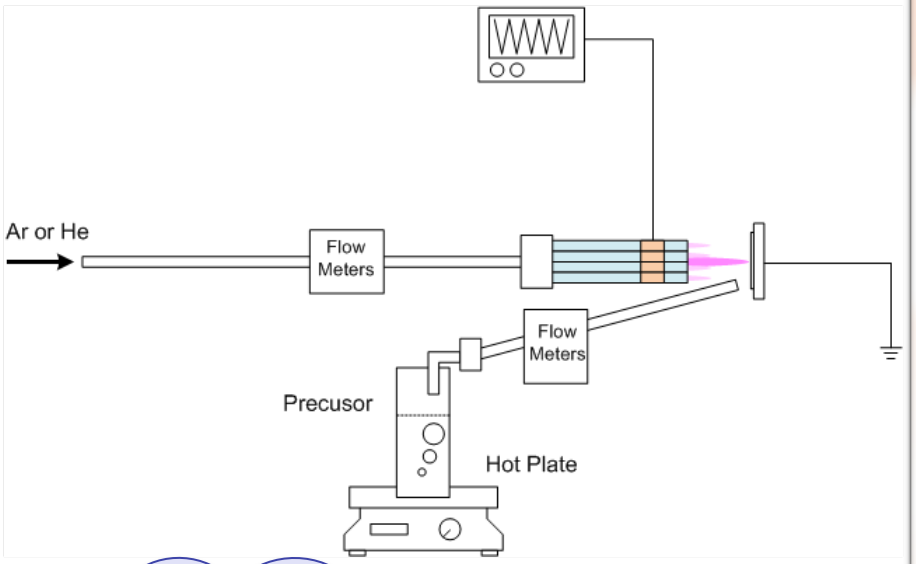

PMMA grating structure on silicon substrate
Dortmund University of technology

# Proposal

## Graphene



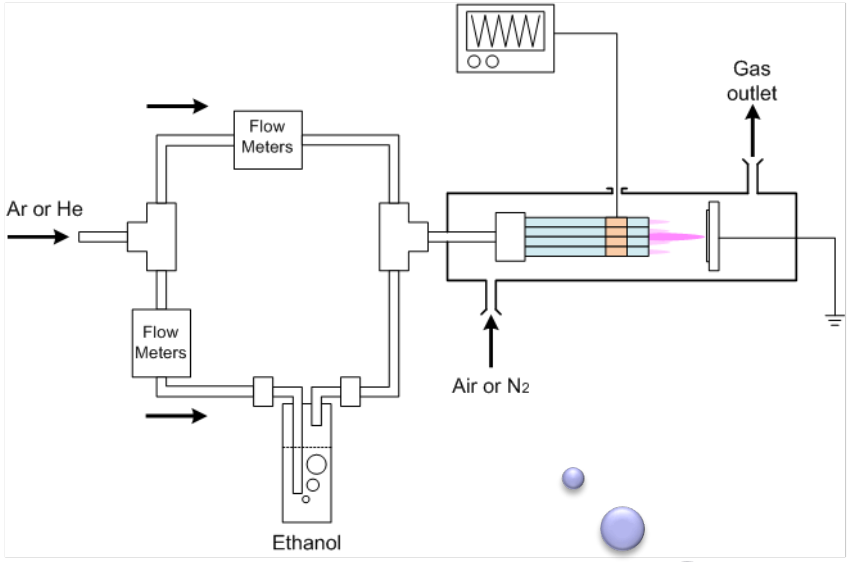

## PMMA



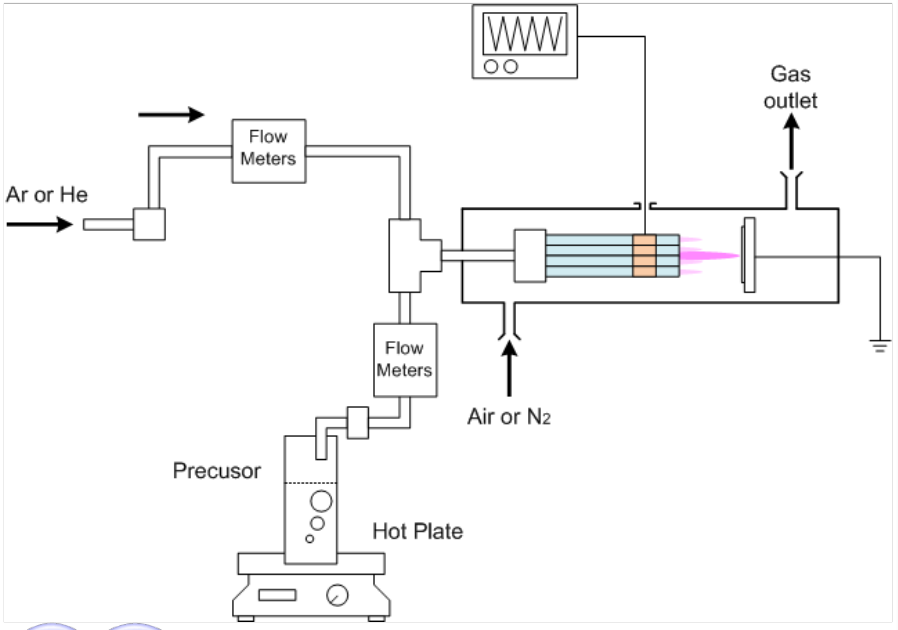

Homogeneous ?
Contaminant ?

# Proposal

## Graphene



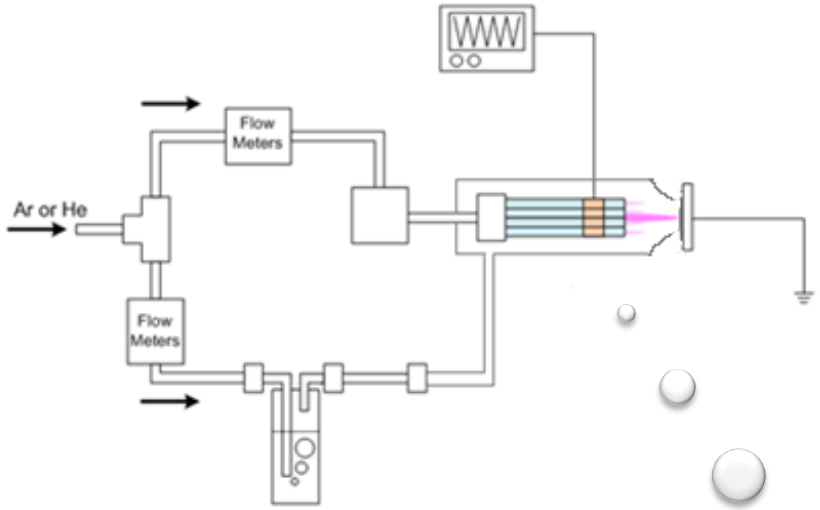

## PMMA



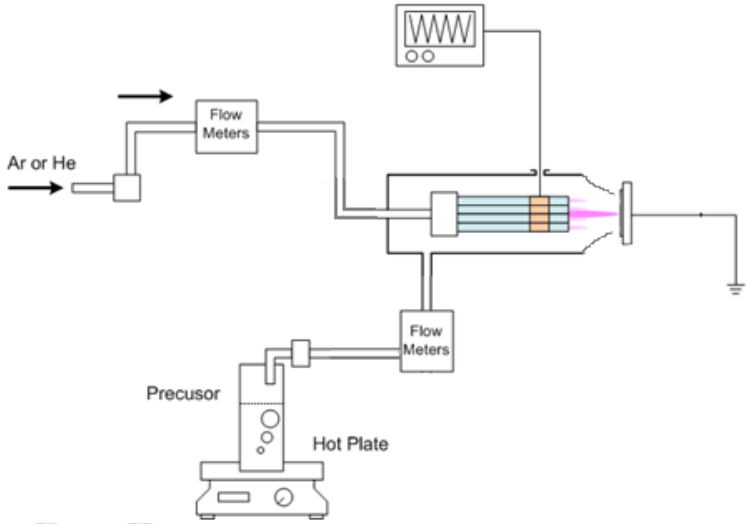

Deposit back to tube?

# Proposal

## Graphene



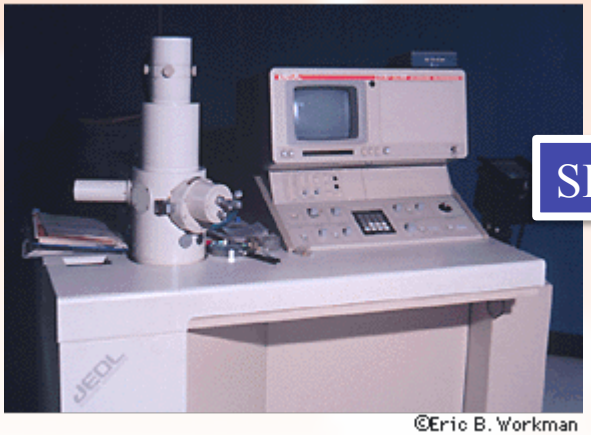

## PMMA




Contact between electrode and monomer, reactive species?

# Quality Measurement

TEM

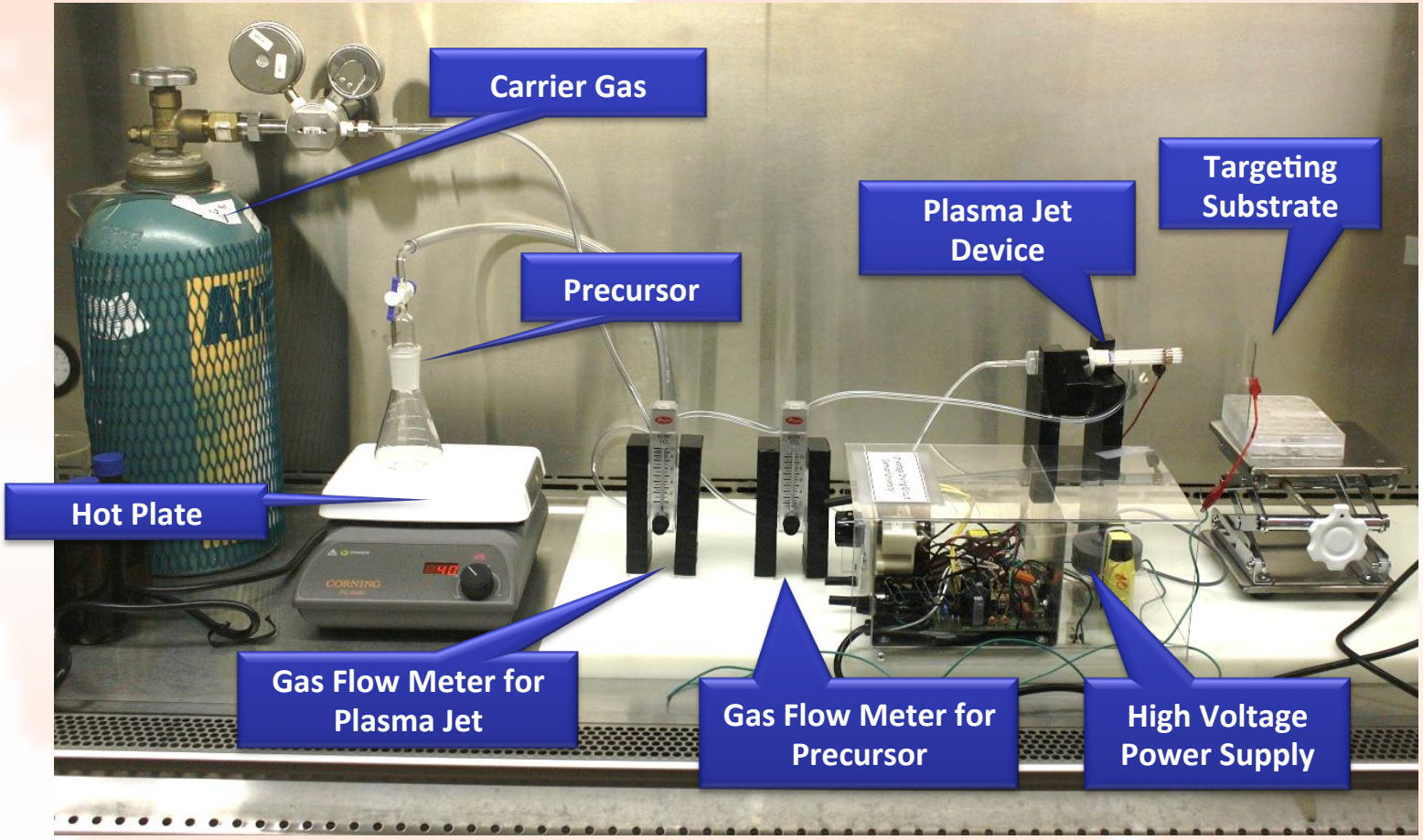



©Eric B. Workman

SEM

AFM

# Our Plasma Thin Film Deposition System



# Summary

- Thin Film Deposition in generous
- Atmospheric Pressure Plasma Thin Film Deposition
- Research Proposal