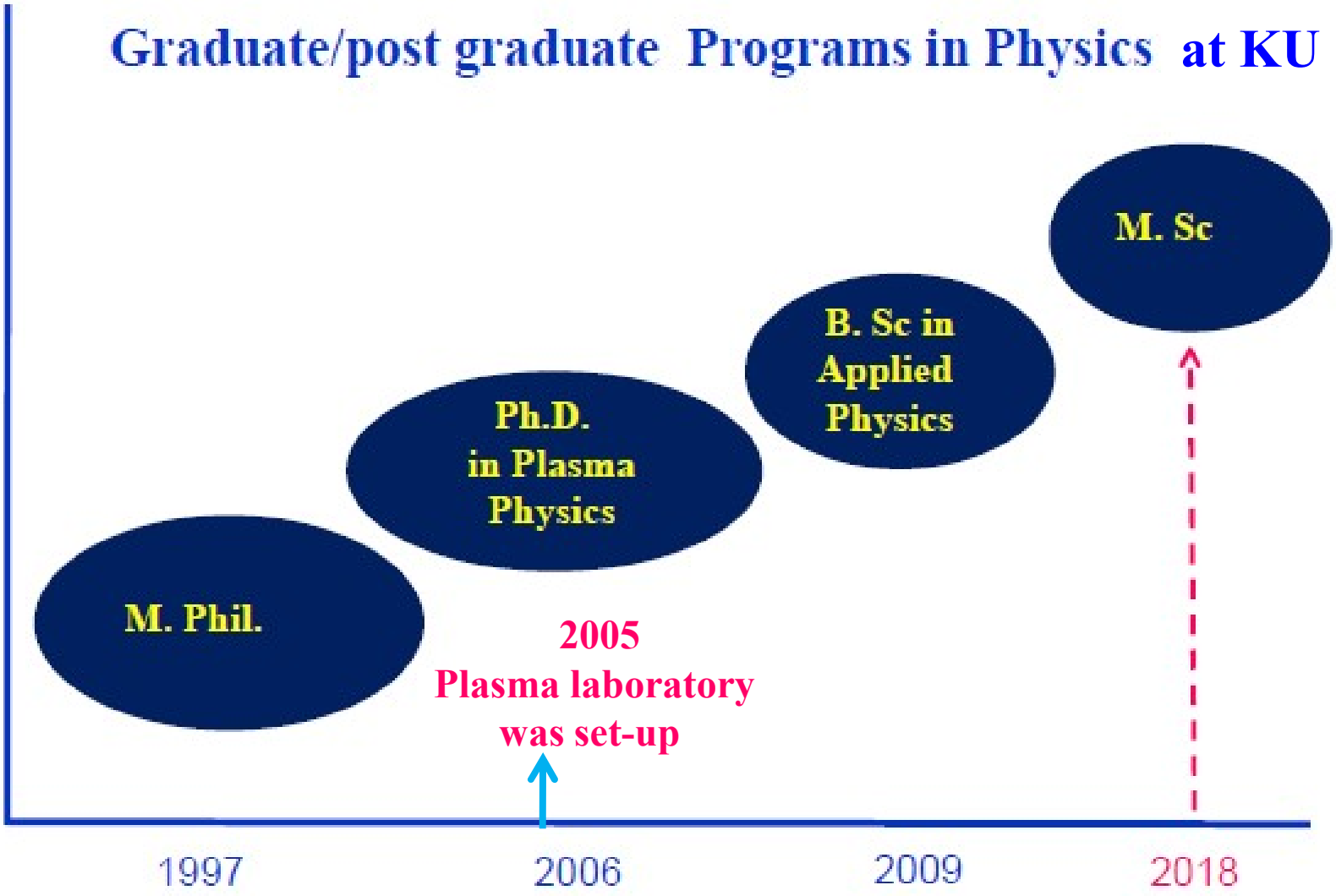
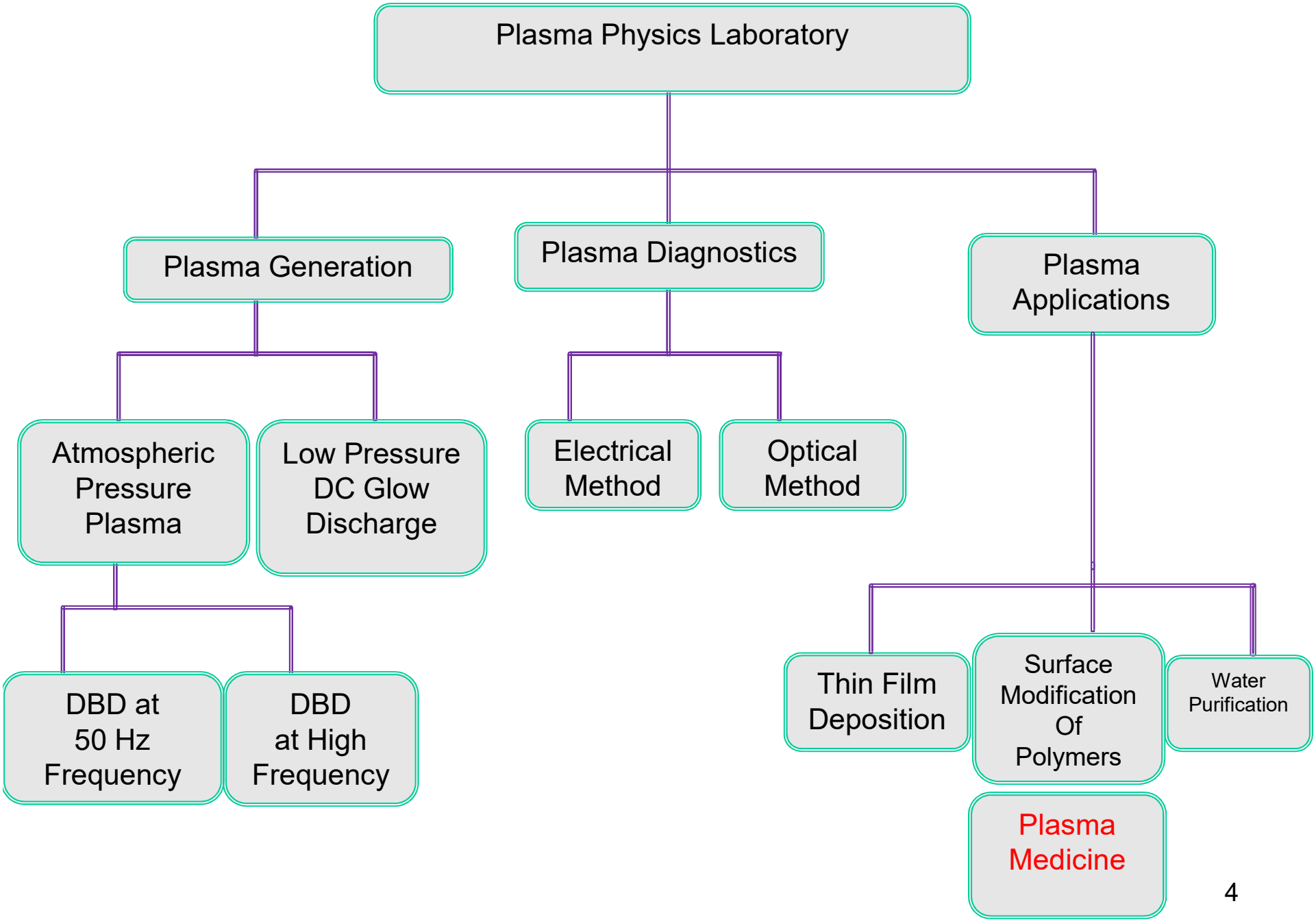
An overview of Plasma Activities at Kathmandu University

Dept. of Physics, School of Science, Kathmandu University

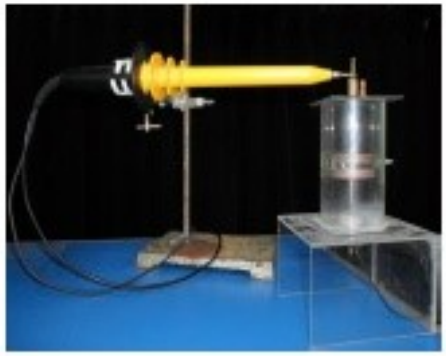
Outline

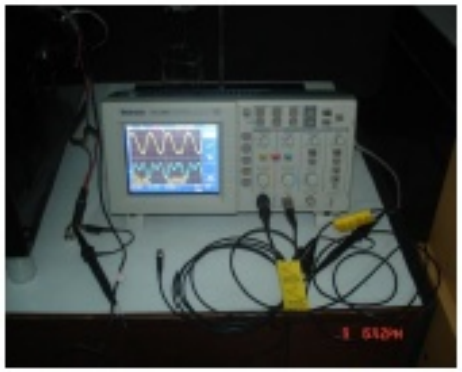
1. Brief Introduction to Kathmandu University
2. Plasma Research in KU
   - 2.1 Plasma Generation
   - 2.2 Plasma Diagnostics
   - 2.3 Plasma Application
3. Physics related activities organized by KU
4. Future Plan


Graduate/post graduate Programs in Physics at KU
M. Sc
B. Sc in Applied Physics
Ph.D. in Plasma Physics
M. Phil.
2005
Plasma laboratory was set-up
1997
2006
2009
2018

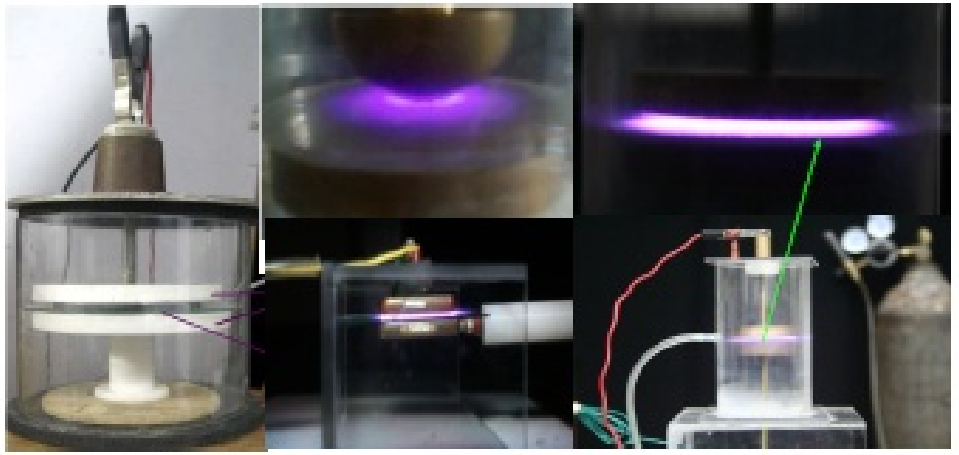

Plasma Physics Laboratory
Plasma Generation
Plasma Diagnostics
Plasma Applications
Atmospheric Pressure Plasma
Low Pressure DC Glow Discharge
Electrical Method
Optical Method
DBD at 50 Hz Frequency
DBD at High Frequency
Thin Film Deposition
Surface Modification Of Polymers
Water Purification
Plasma Medicine

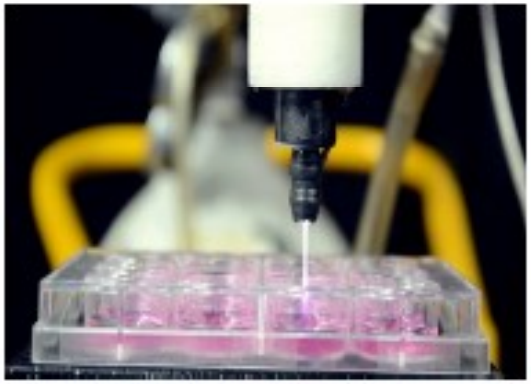
Plasma Research Facilities at KU

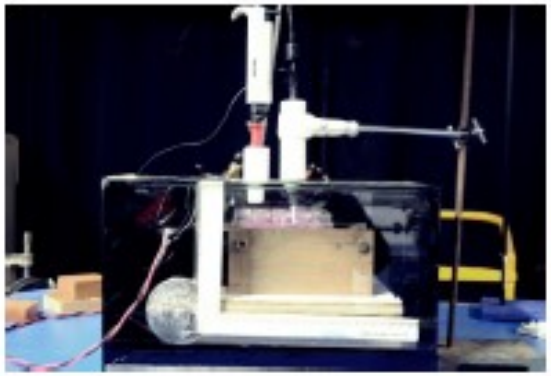


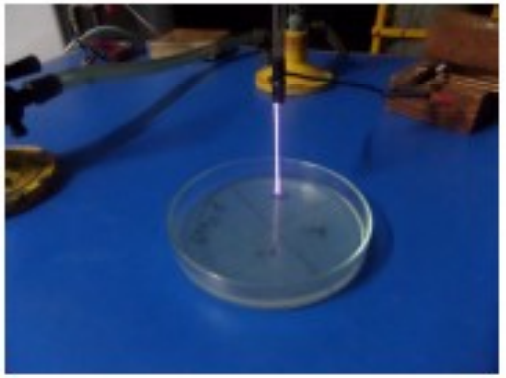


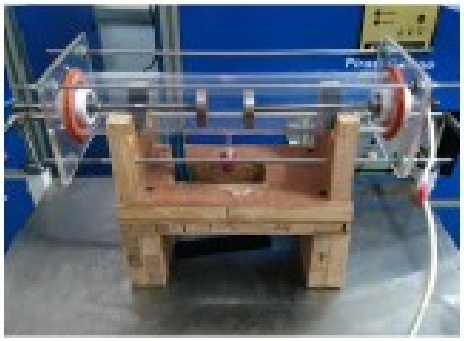
Plasma Research Facilities at KU











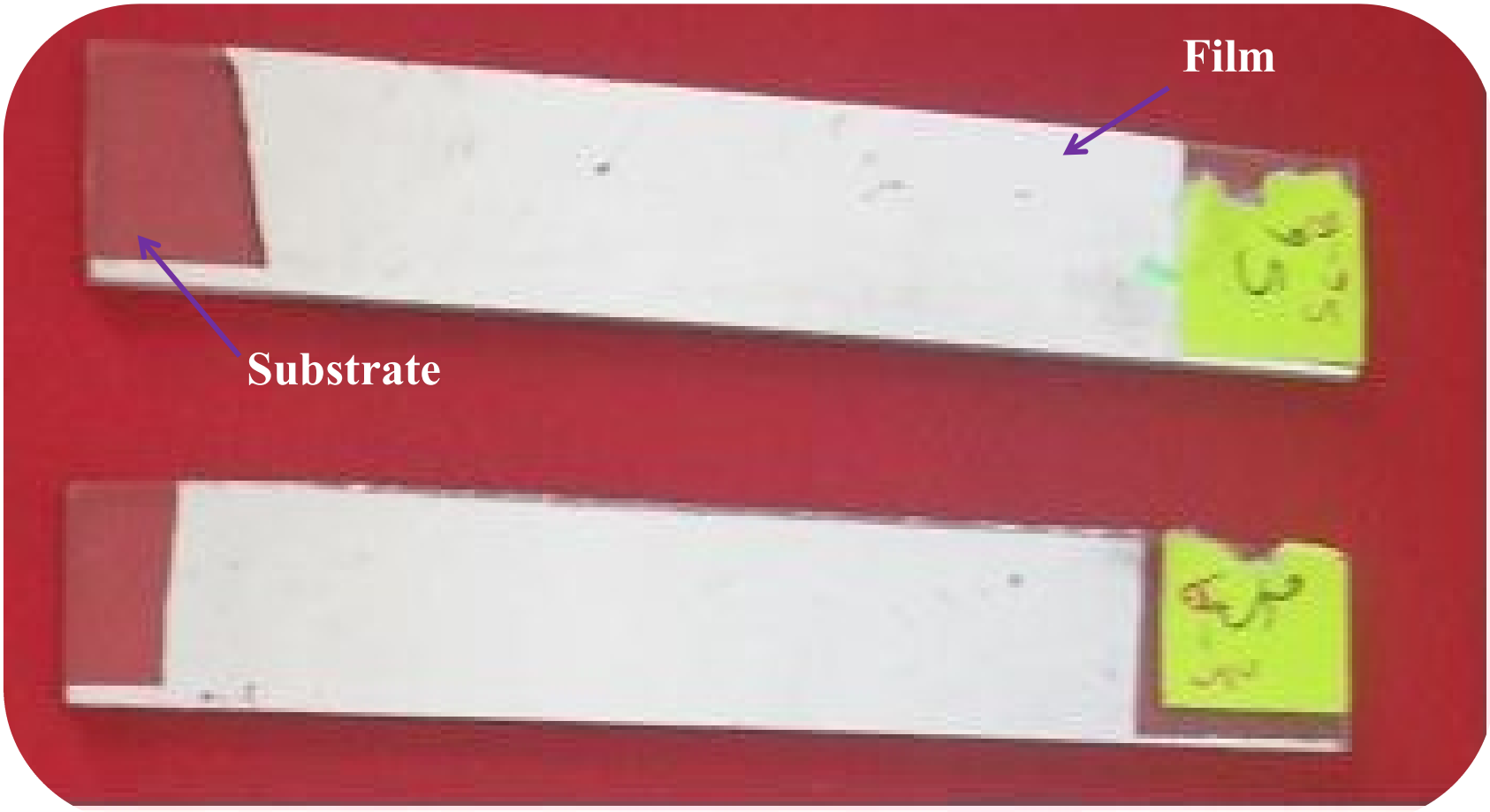
Plasma reactor used for thin film deposition

The system is used for training research students (Ph.D., M. Phil & M.Sc.) in the field of film deposition technology.

The important parts of the system

1. Vacuum Chamber
2. Rotary pump
3. Diffusion pump
4. Pirani gauge
5. Penning gauge
6. Control unit- *In situ* thickness monitoring

Deposition of Thin Films

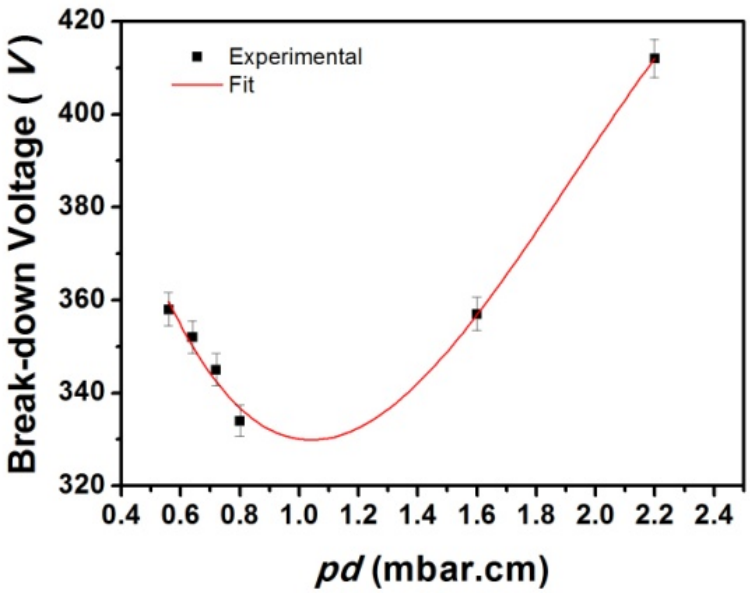


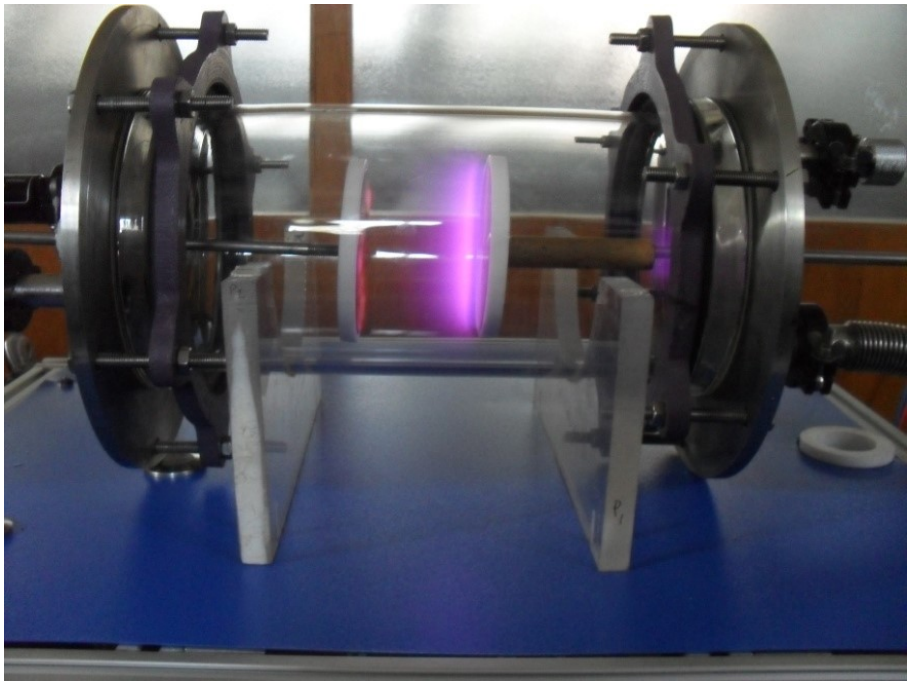
Low Pressure DC Glow discharge systems

Paschen Curve

- Breakdown of a gas in uniform dc electric field is given by Paschen's law

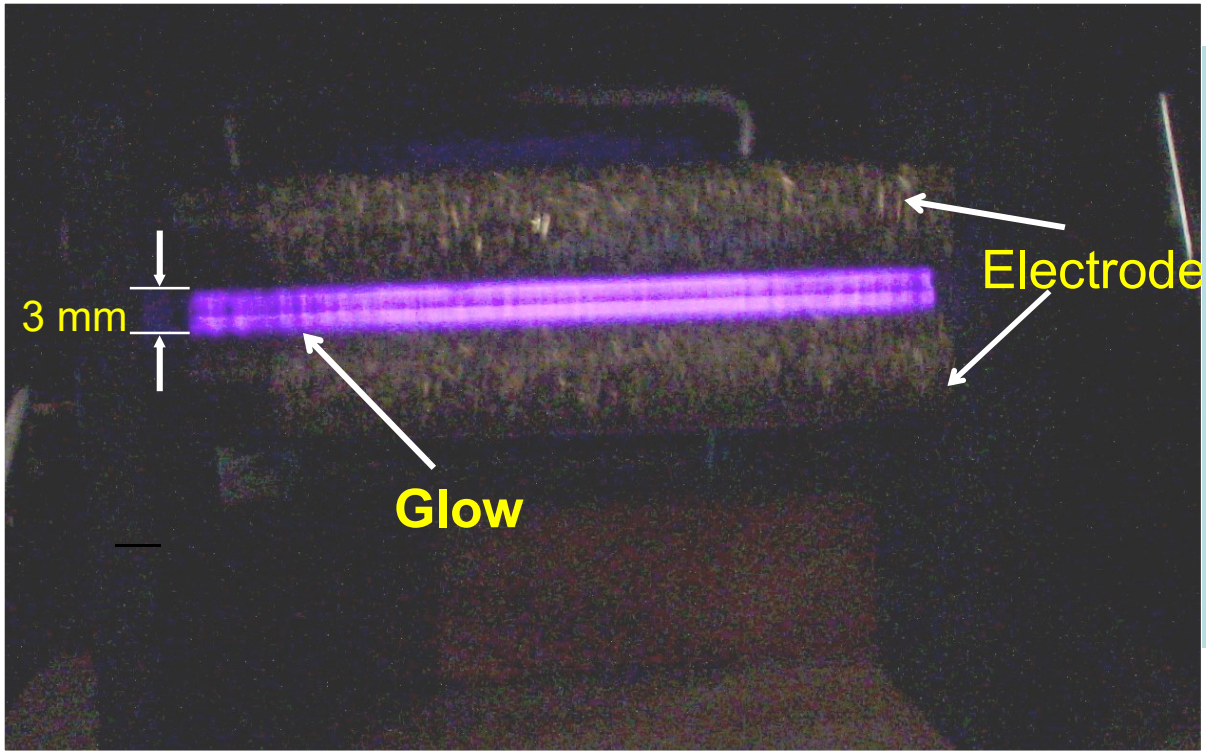
$$V = \frac{a(pd)}{\ln(pd) + b}$$





J. Alphonsa and A. Satyaprasad

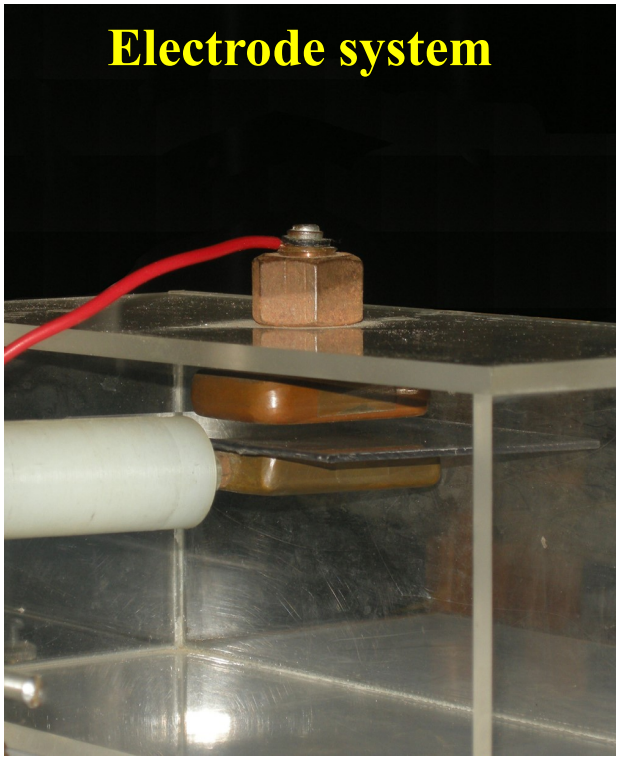
Dielectric Barrier Discharge (DBD) in Air

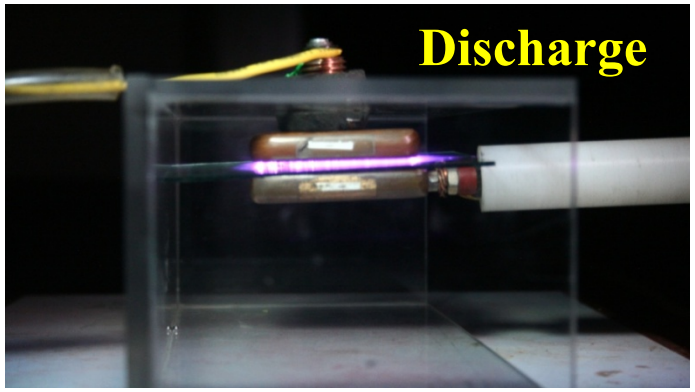


Produced using High voltage-AC Power supply Operating at a frequency of 10-30 kHz.
with double barrier.
This system has been used for studying plasma surface modification of polymers and textiles.

G. Shrestha, P. Freere, S. M. Basnet, W.T. Jewel and D. P. Subedi,
IEEE, Region 5 Technical Conference, pp. 432-435, 2007

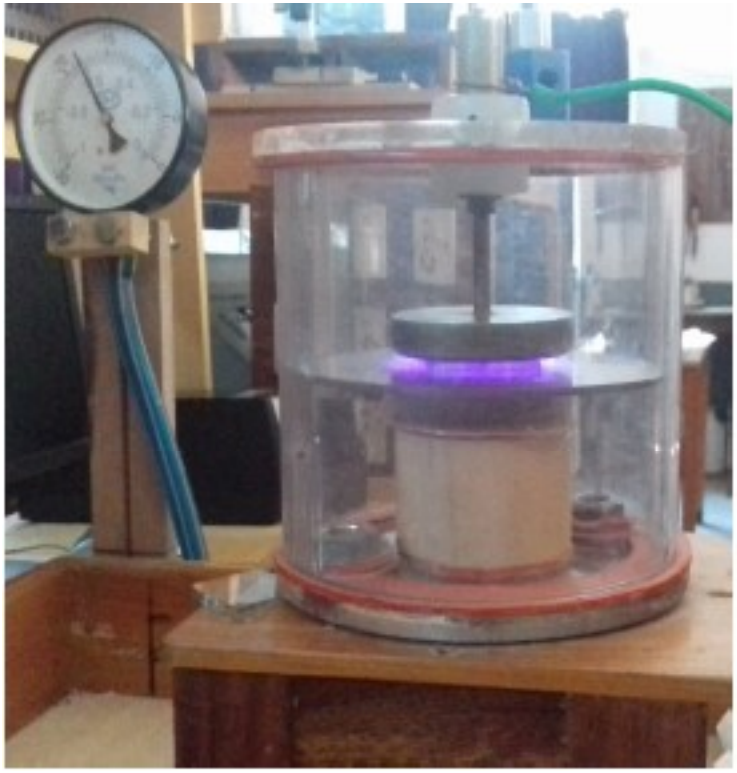
Atmospheric Pressure DBD using a 50 Hz HV power supply





Copper electrode:
5 cm × 3.5 cm × 1 cm

DBD at Near Atmospheric Pressure



Development of a Cold Plasma Generator for Atmospheric Pressure Dielectric Barrier Discharge

G. Shrestha, P. Freere, S. M. S. Basnet, W. T. Jewell, D.P. Subedi

Keywords -- Plasma, dielectric barrier discharge, high voltage high frequency generator.

II. DIELECTRIC BARRIER DISCHARGE

1-4244-1280-3/07/$25.00 ©2007 IEEE

2007 IEEE Region 5 Technical Conference, April 20-21, Fayetteville, AR

AIP ADVANCES 7, 085213 (2017)

Improvement of wettability and absorbancy of textile using atmospheric pressure dielectric barrier discharge

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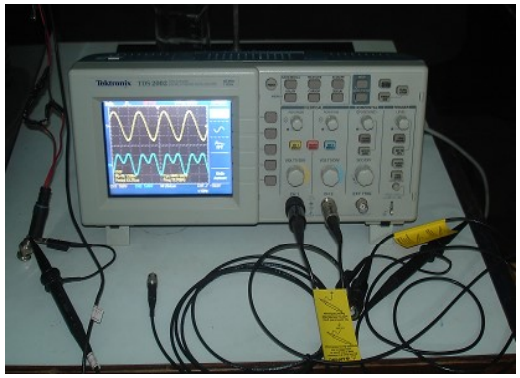
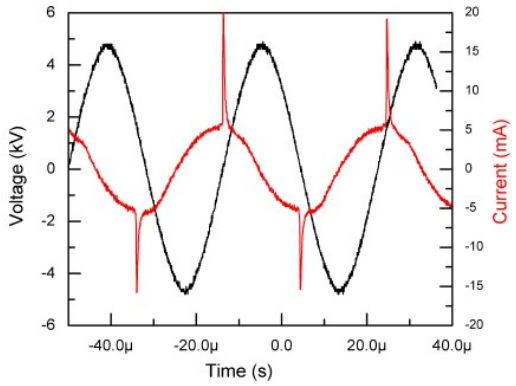
[2]*Department of Natural Sciences, Kathmandu University, Dhulikhel, Nepal*
[3]*Central Department of Physics, Kirtipur, Kathmandu, Nepal*

(Received 27 June 2017; accepted 7 August 2017; published online 16 August 2017)

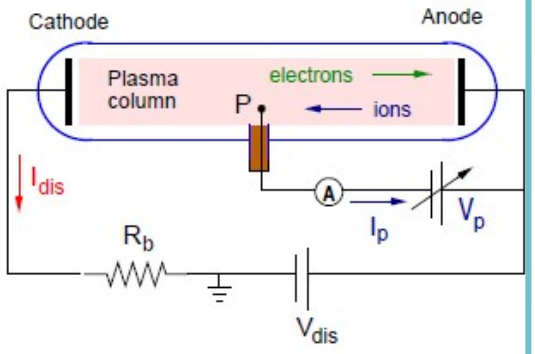
Plasma Diagnostics

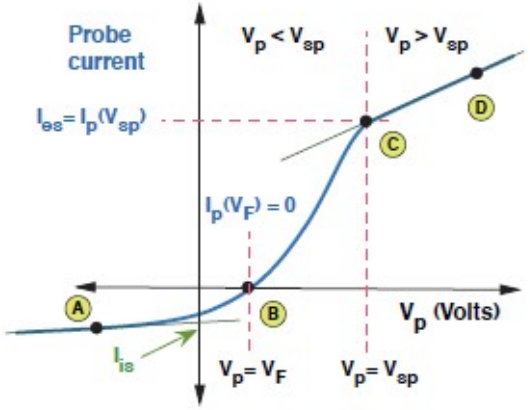
I-V measurement For DBD



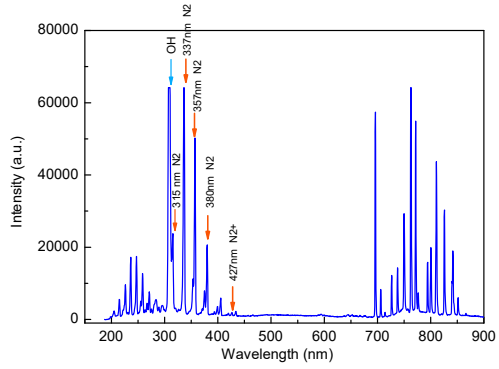


Langmuir probe



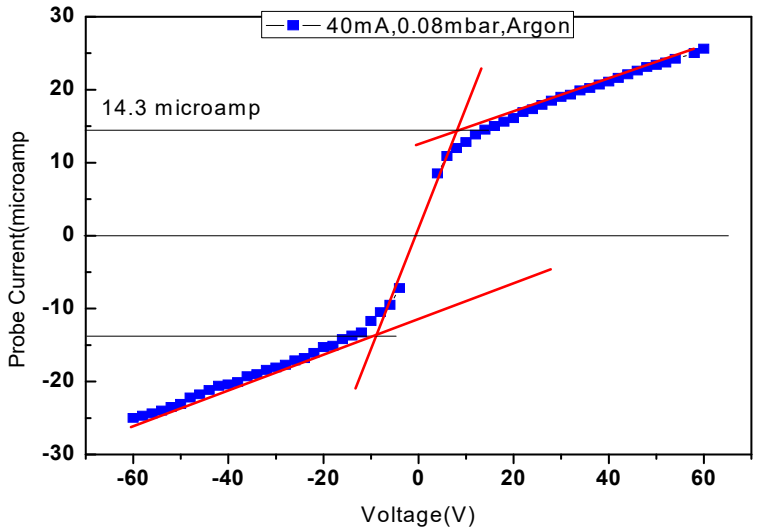


Optical Emission Spectrometer



Plasma Diagnostics: Double Probe

- Double probe, uses 2 metallic wires or same dimensions immersed in low pressure plasma.
- Using double probe theory plasma parameters (n_i, T_e) can be obtained



Parameter	Range
Gas	Argon
Discharge Current	0.04 A
Electron Temperature	4 eV
Plasma Density	5 x 10^9/cm^3
Ion Saturation	14-15micro amp

R. Rane and S. Mukherjee

Diagnostics of Atmospheric pressure plasma

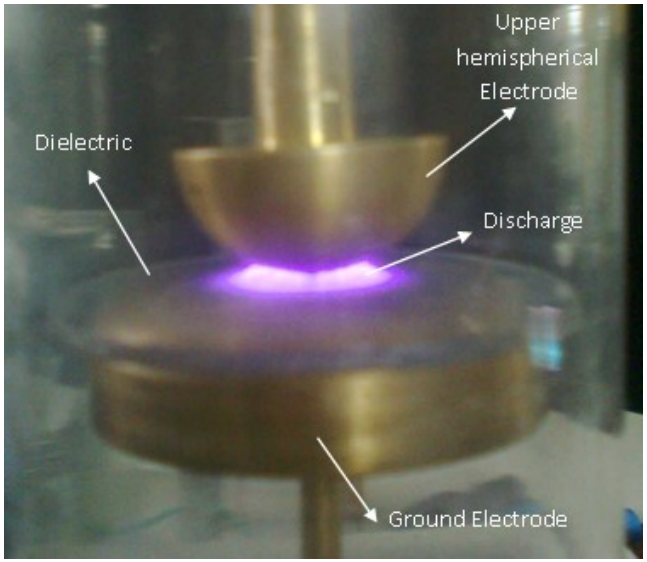
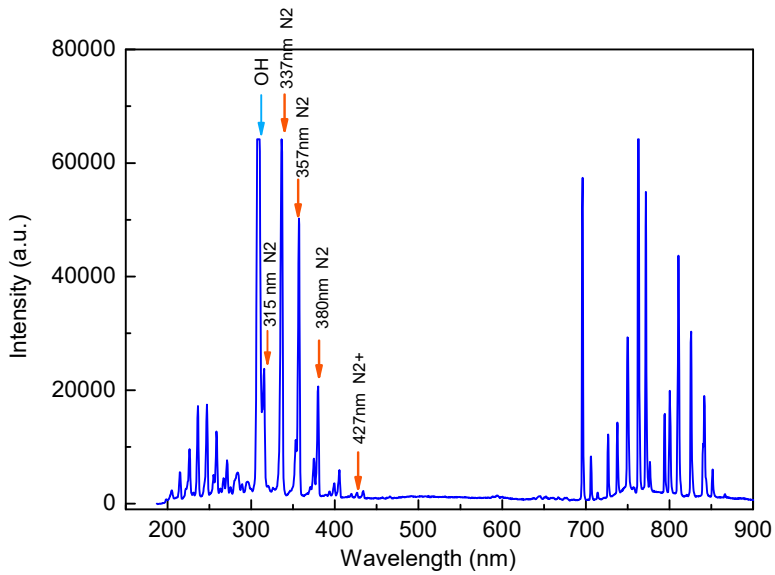


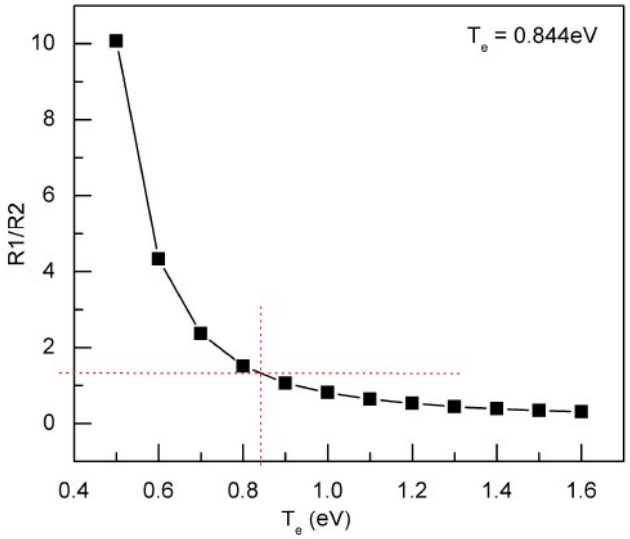
Fig: Photograph of discharge Hemispherical Electrode

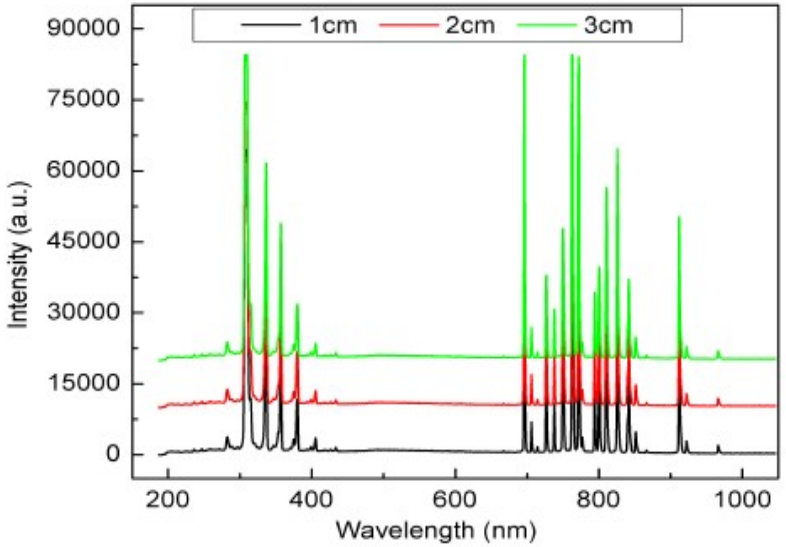


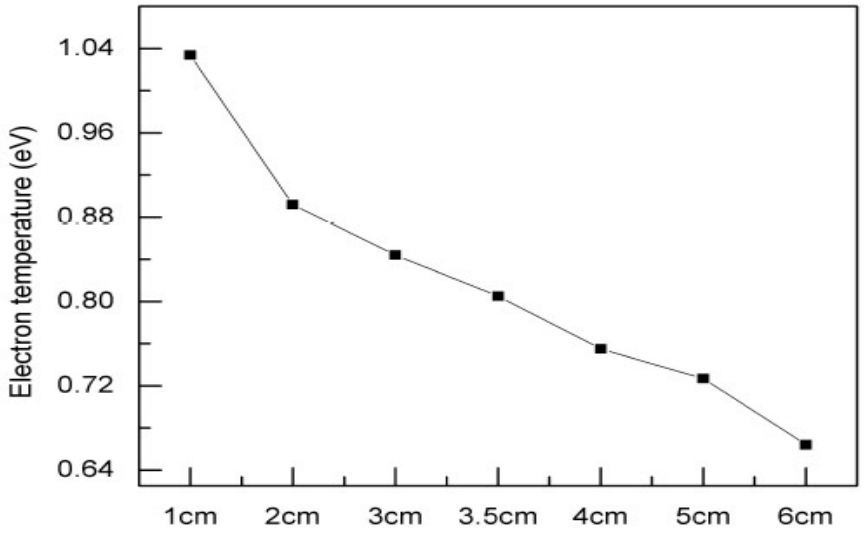
Electron Temperature (Line intensity ratio method)

$$\frac{R_1}{R_2}=\frac{I_1/I_2}{I_3/I_4}=\left(\frac{A_{pq}}{A_{xy}}\right)\left(\frac{g_p}{g_x}\right)\left(\frac{\lambda_{xy}}{\lambda_{pq}}\right)\left(\frac{A_{uv}}{A_{rs}}\right)\left(\frac{g_u}{g_r}\right)\left(\frac{\lambda_{rs}}{\lambda_{uv}}\right)\exp\left[-\frac{E_p-E_x-E_r+E_u}{kT_e}\right]-$$

ArI (696.54 nm)	$A_{pq}=6.39\times10^6$	$g_p=5$	$E_p=11.564$ eV
ArI (751.034 nm)	$A_{rs}=4.02\times10^7$	$g_r=3$	$E_r=11.636$ eV
ArII (314.13 nm)	$A_{xy}=5.20\times10^7$	$g_x=6$	$E_x=19.249$ eV
ArII (378.75 nm)	$A_{uv}=10.5\times10^6$	$g_u=8$	$E_u=16.797$ eV



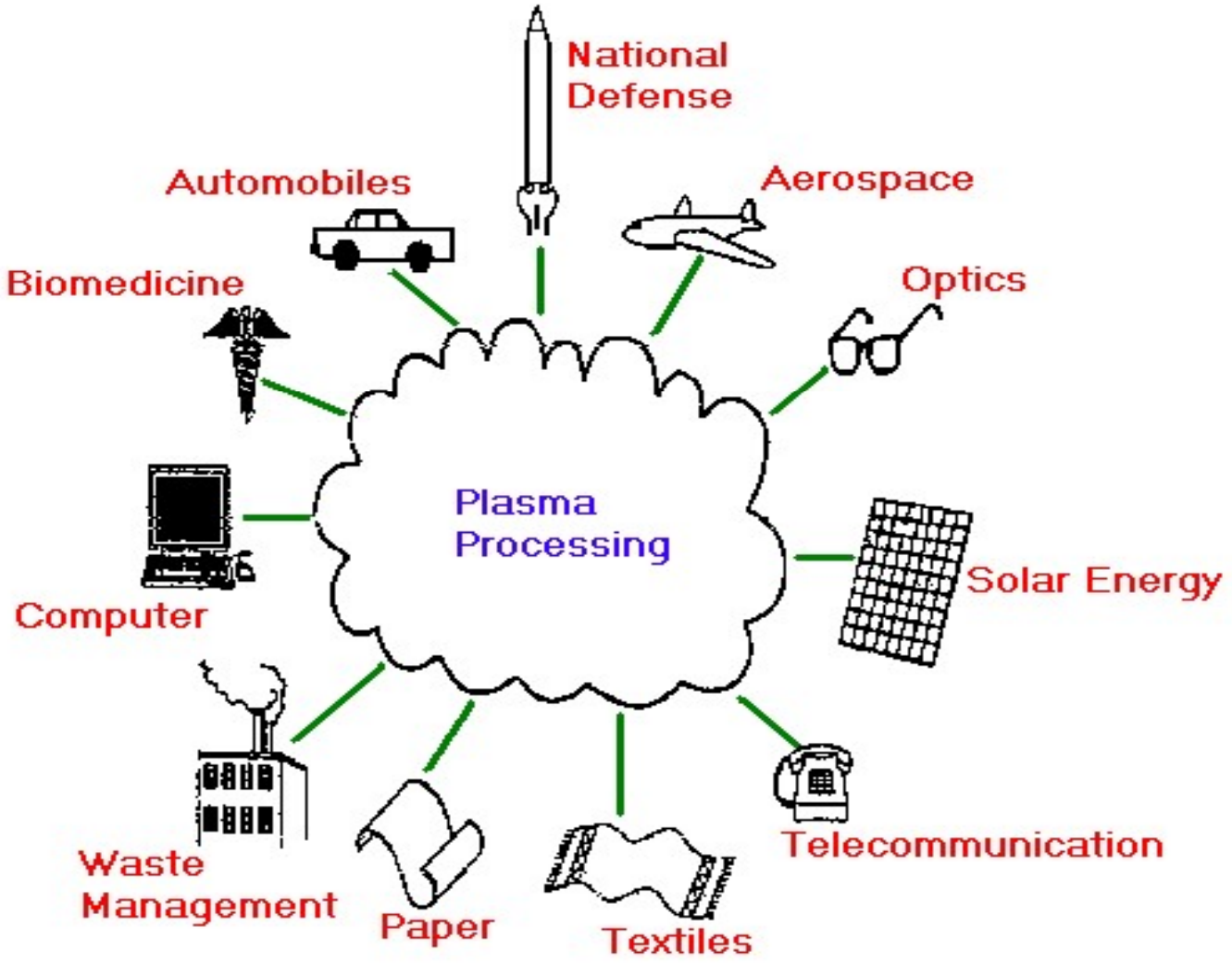




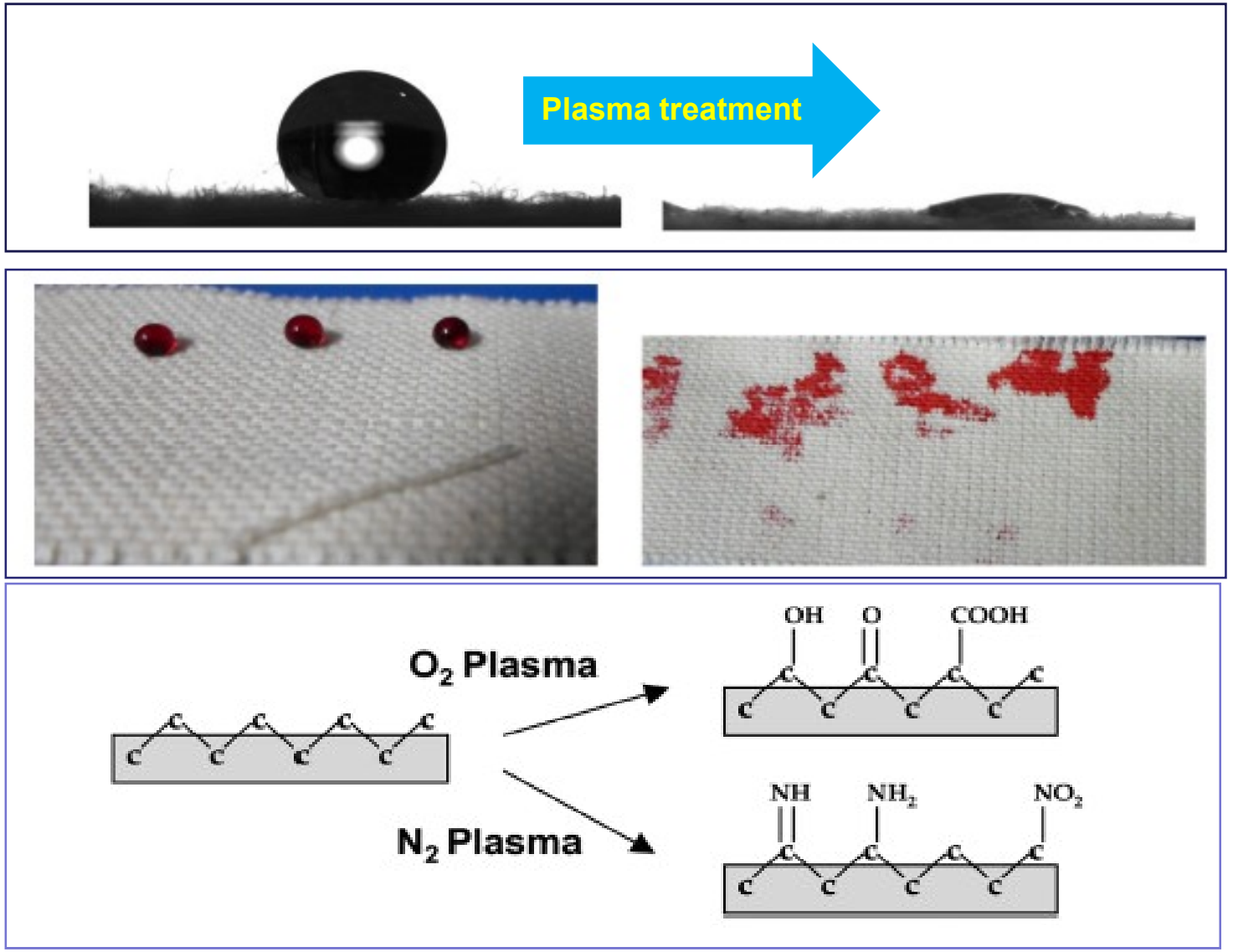
Axial distance (cm)

Plasma Application

Plasma Processing

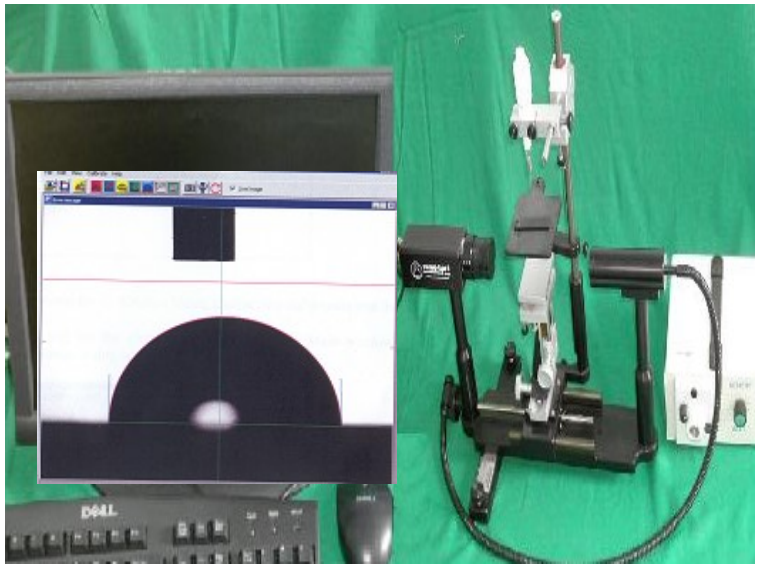


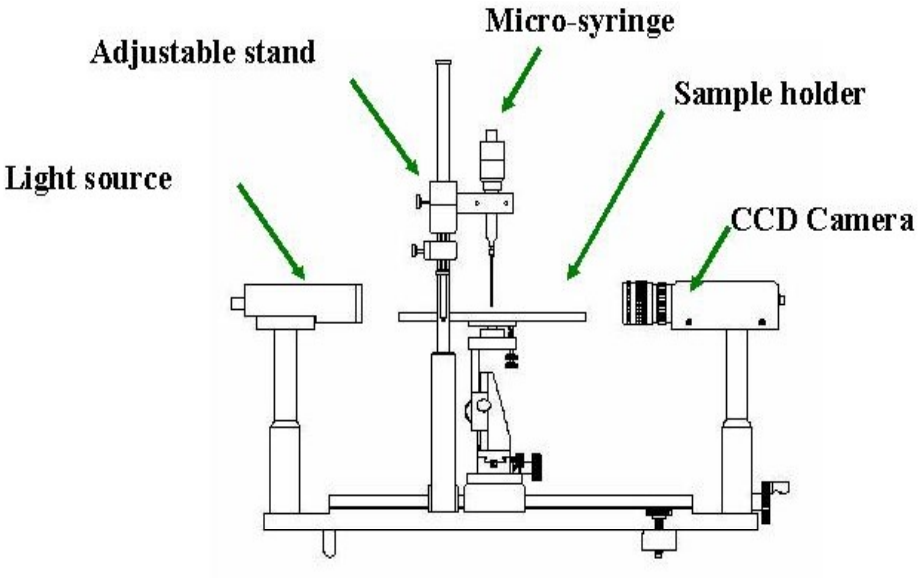
Plasma Treatment of Cotton



B. Ghimire, D. P. Subedi and R. Khanal, *AIP Advances* **7**, 085213 (2017)

Surface Characterization of Plasma Treated Solids



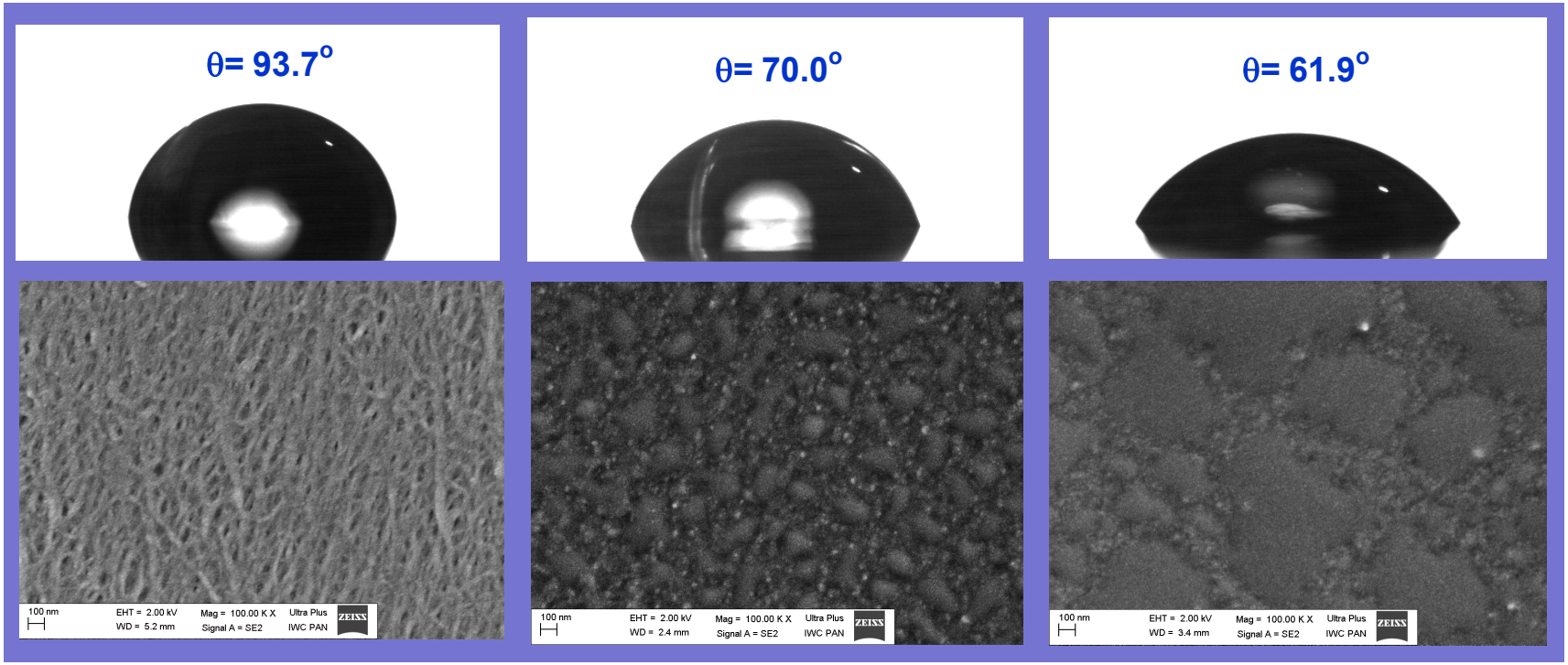


$$\gamma_L(1+\cos\theta)=2(\gamma_L^{LW}\cdot\gamma_S^{LW})^{1/2}+2(\gamma_L^{+}\cdot\gamma_S^{-})^{1/2}+2(\gamma_L^{-}\cdot\gamma_S^{+})^{1/2}$$

Liquid	Density	Total (γ)	Disp. (γ^{LW})	Polar (γ^{AB})	Polar+ (γ^{+})	Polar– (γ^{-})
Water	0.9982	72.8	21.8	51.0	25.5	25.5
Glycerol	1.0023	63.9	37.5	26.4	3.9	57.4
Diiodomethane	3.3250	50.8	50.8	0	0	0

Sessile Drop and SEM Images of PP

Untreated	Treated in air plasma	Treated in argon plasma
θ= 93.7°	θ= 70.0°	θ= 61.9°



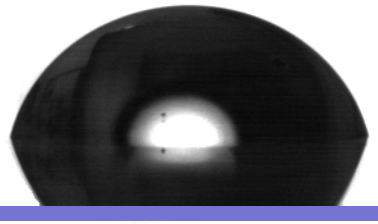
SEM observations of PP film surface before and after the plasma treatment (1 min)

Sessile Drop and AFM Images of PET

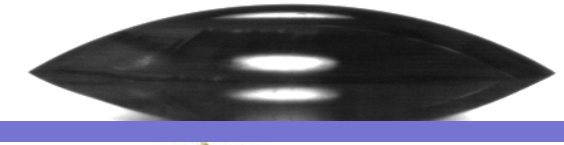
Untreated

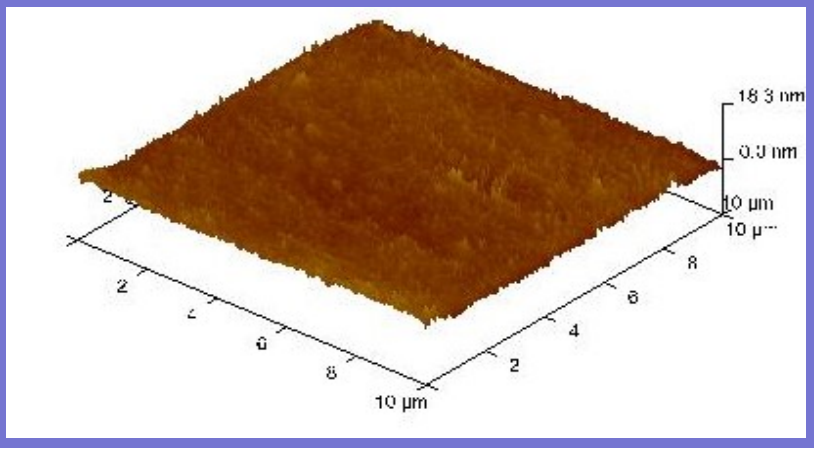
Treated in argon plasma

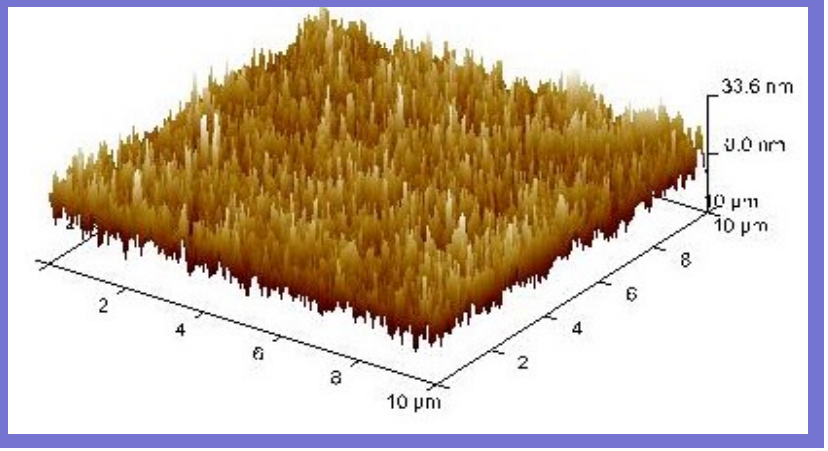
θ= 76.6°



θ= 32.9°







PRAMANA
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Generation of uniform atmospheric pressure argon glow plasma by dielectric barrier discharge

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Cost Effective Plasma Technology For Bio-Medical Materials Treatment

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[a]*Plasma Technology Research Centre, Physics Department, University of Malaya, Malaysia*
[b]*Physics Department, Faculty of Science, Chulalongkorn University, Thailand*
[c]*Department of Chemical Engineering, Chulalongkorn University, Thailand*
[d]*Department of Natural Sciences, Science Faculty, Kathmandu University, Dhulikhel, Nepal*
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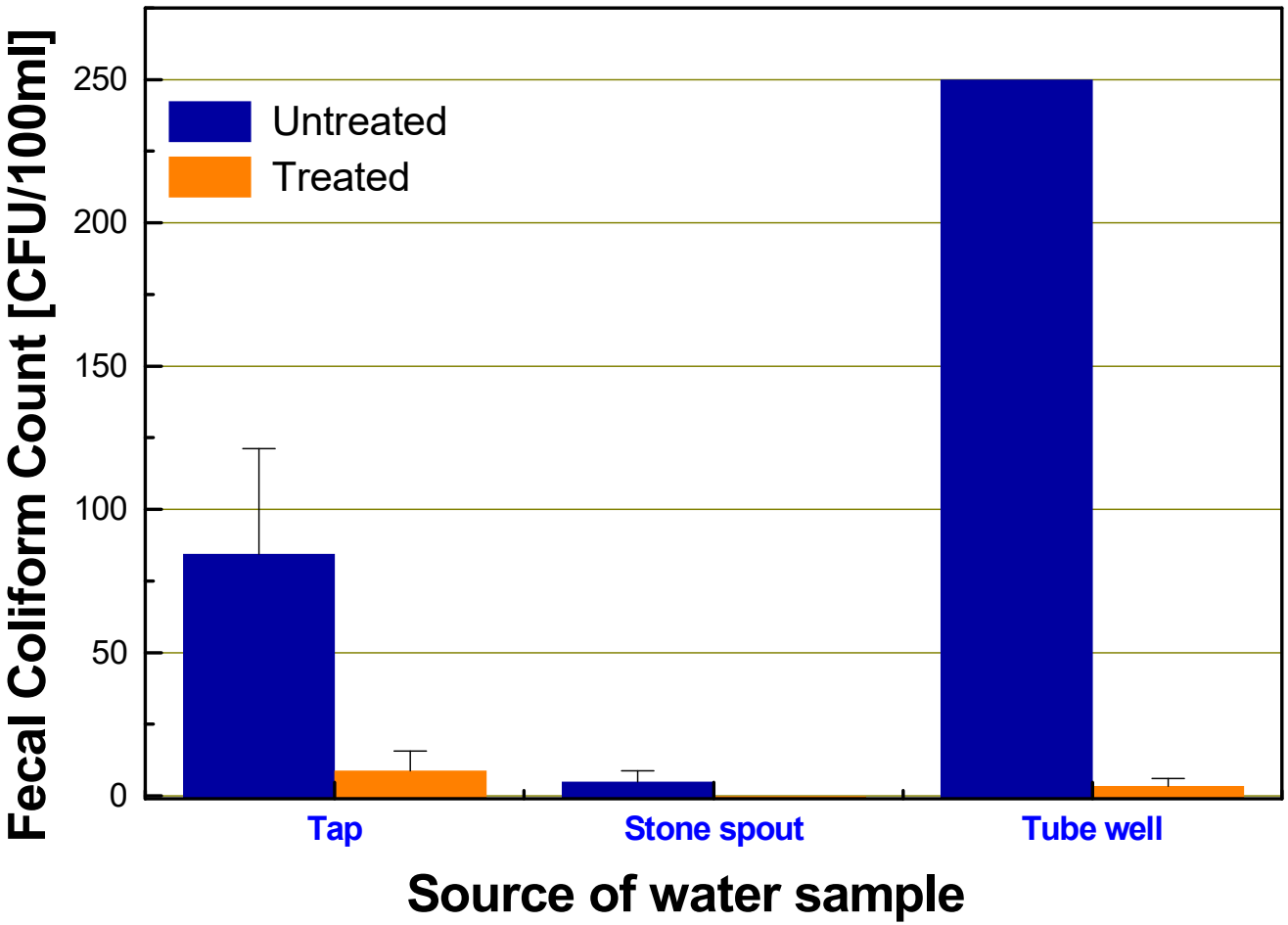
Abstract. In this paper, we summarise the efforts of our group in the development of cost effective plasma devices for applications in the treatment of materials, in particular bio-medical materials.

Keywords: Plasma devices; bio-medical materials.
PACS: 52.8.-s

Plasma for Ozone generation and water treatment

Fecal Coliform



D. P. Subedi, R.B. Tyata, A. Khadgi & C.S. Wong, Physicochemical & Microbiological analysis of Drinking water treated by using ozone. Sains Malaysiana**, 41**, (2012) pp 739-745.

Sains Malaysiana 41(6)(2012): 739 –745

Physicochemical and Microbiological Analysis of Drinking Water Treated by Using Ozone

(Analisis Fisikokimia dan Mikrobiologi Air Minimum yang dirawat dengan Ozon)

D.P. SUBEDI, R.B. TYATA, A. KHADGI & C.S. WONG*

Hindawi Publishing Corporation
Journal of Chemistry
Volume 2015, Article ID 648162, 6 pages
http://dx.doi.org/10.1155/2015/648162

Research Article

Treatment of Wastewater by Ozone Produced in Dielectric Barrier Discharge

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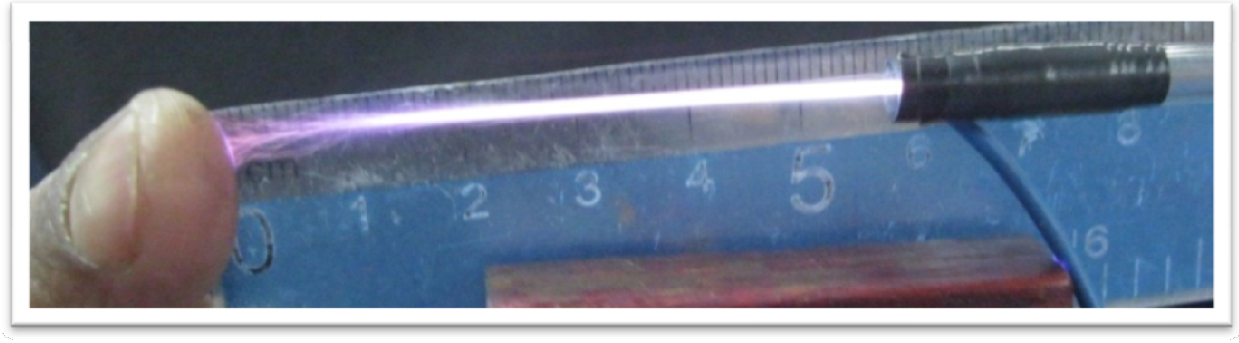
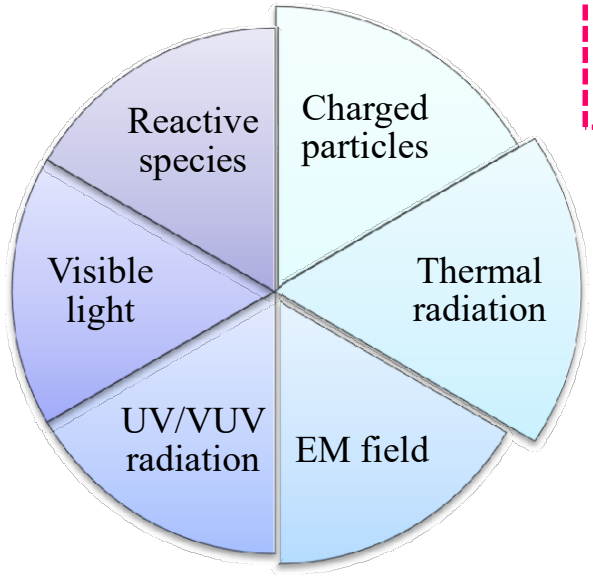
Academic Editor: Victor David

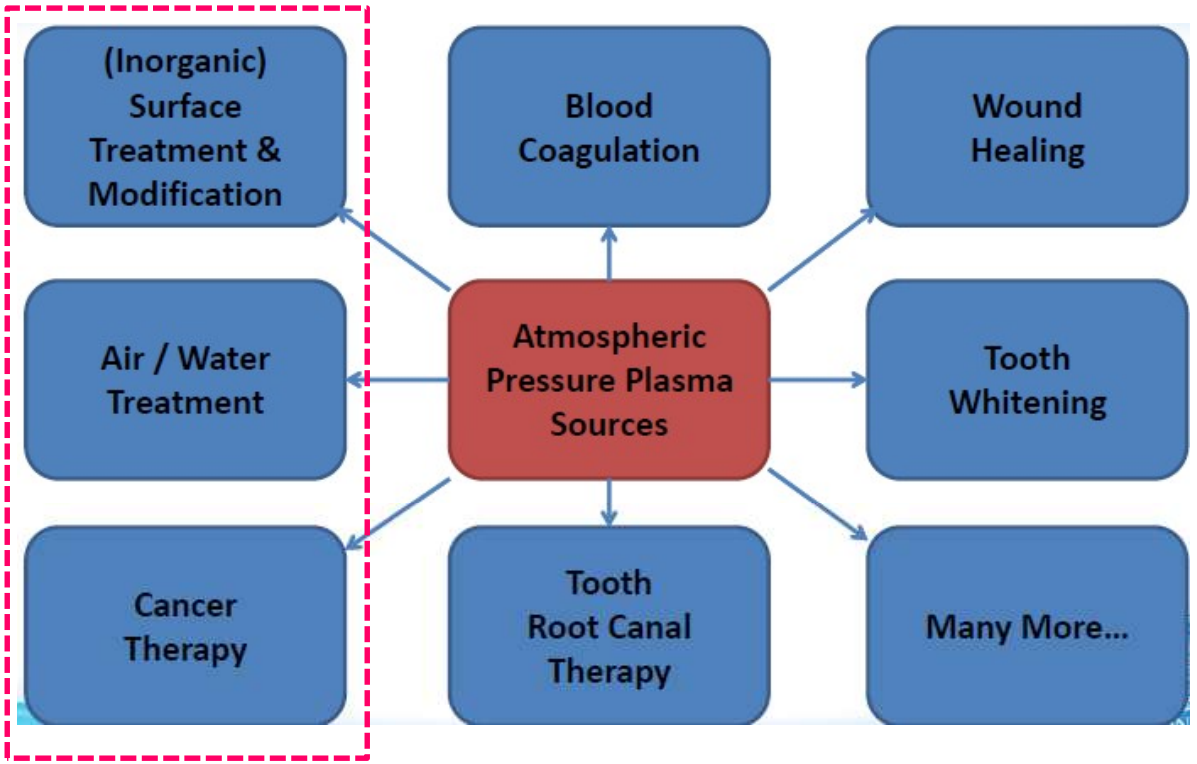
Plasma Medicine

Atmospheric Pressure Plasma Jet (APPJ)



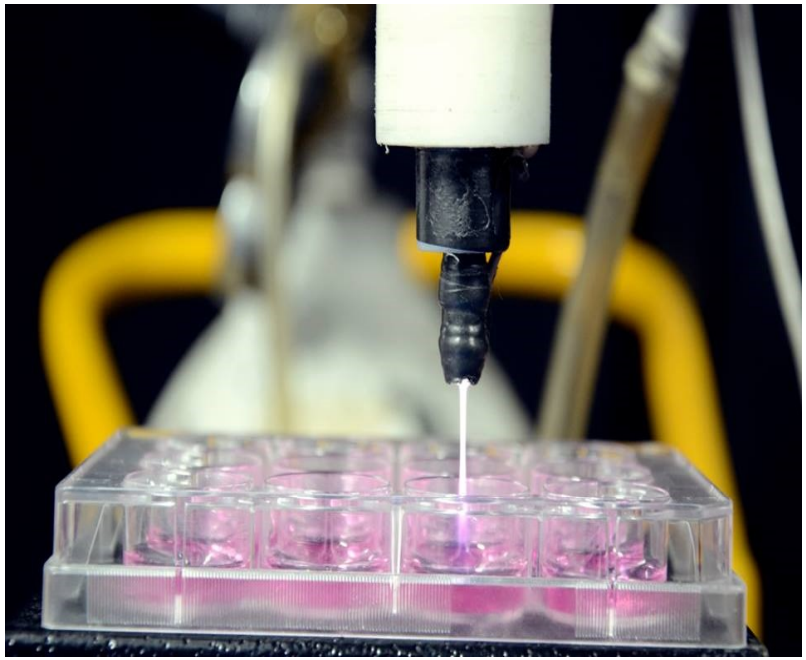
Plasmas can act as an sterilizer



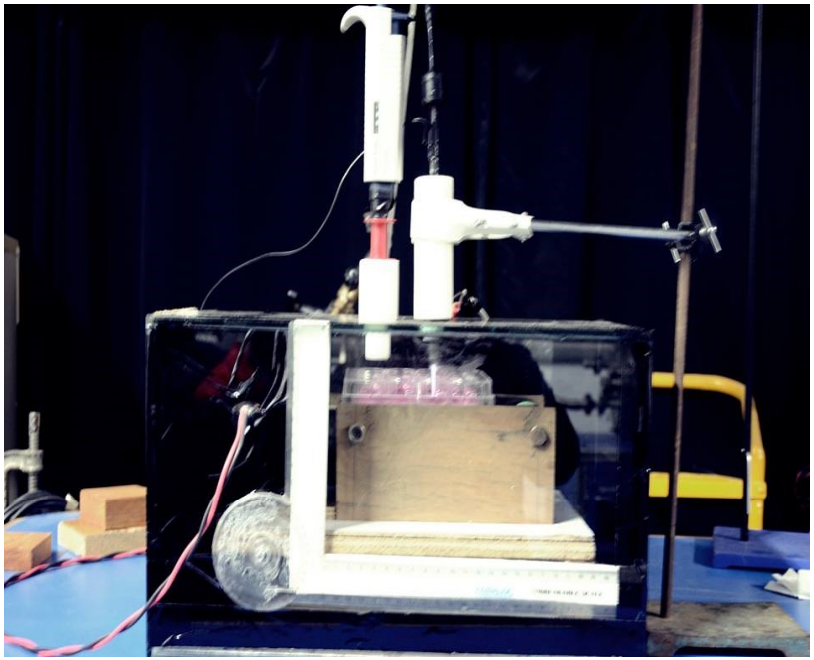


Currently studied area at KU

Treatment of cells by APPJ



Treatment in cell culture media



Treatment in Breast Cancer

- Cells are grown in 12-well culture plates as recommended in 5% CO_2 at 37 ^{o}C and 95% humidity.

- Cell culture is left out with little medium (100 µl) to prevent desiccation of the sample.

National and International Research Grants

Year	Title of the project	Funding source /amount
2004	Study of Refractive index of salt solutions	UGC, Nepal
2007	Fabrication and characterization of Al^{3+}/Er^{3+} ion doped thin films as anode materials for white light emitting diodes.	Third World Academy of Sciences (TWAS), Italy
2008	Development of dielectric barrier Discharge unit for the purification of water.	International Foundation for Science (IFS), Sweden
2009	Eleventh UNESCO workshop on Active Learning in Optics and Photonics, July 11-16, 2009	UNESCO, France
2010	Fabrication and characterization of Al^{3+}/Er^{3+} ion doped thin films as anode materials for white light emitting diodes. **(Renewed)**	Third World Academy of Sciences (TWAS), Italy
2011	Development of dielectric barrier Discharge unit for the purification of water. **(Renewed)**	International Foundation for Science (IFS). Sweden
2011	16th UNESCO workshop on Active Learning in Optics and Photonics, Dec 16-21, 2011	UNESCO, France

Output

No. Students trained in our lab		
1.	Ph. D.	3
2.	M. Phil	7
3.	M. Sc.	30
4.	B. Sc.	24

Present Status of research students	
Ph. D.	**3**
M. Phil.	**3**
M. Sc.	**2**

Research Papers: More than 30 papers have been published in journal and proceedings.

Scientific events: National and international level conferences / workshops in plasma physics and material science have been regularly organized since 2005.

icpsa 2014

International Conference on Plasma Science and Applications

22-24 September 2014

Kathmandu, Nepal

Organizers:

Asian African Association for Plasma Training (AAAPT)

Department of Natural Sciences, School of Science, Kathmandu University

and

Central Department of Physics

Tribhuvan University, Kirtipur

AAAPT


2005


2007


2006
KATHMANDU UNIVERSITY
ESTD. 1991


2008
Symposium on Plasma Physics & Material Science

Acknowledgement

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Thank you !