Summer Research Project 2023

SURFACE MODIFICATION OF SOFT PLA-BASED MATERIALS

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Introduction:

- Polylactic acid (PLA) is the most dominant material for Bio-medical applications and after consideration of the properties of PLA like biocompatibility and biodegradability, an experimental study is done for the surface modification of PLA.

Research Objective:

- The Purpose of the experimental study is to focus on surface modification by inducing atmospheric plasma at different voltages, in addition to this different technologies are incorporated for analyzing the induced properties on the surface.
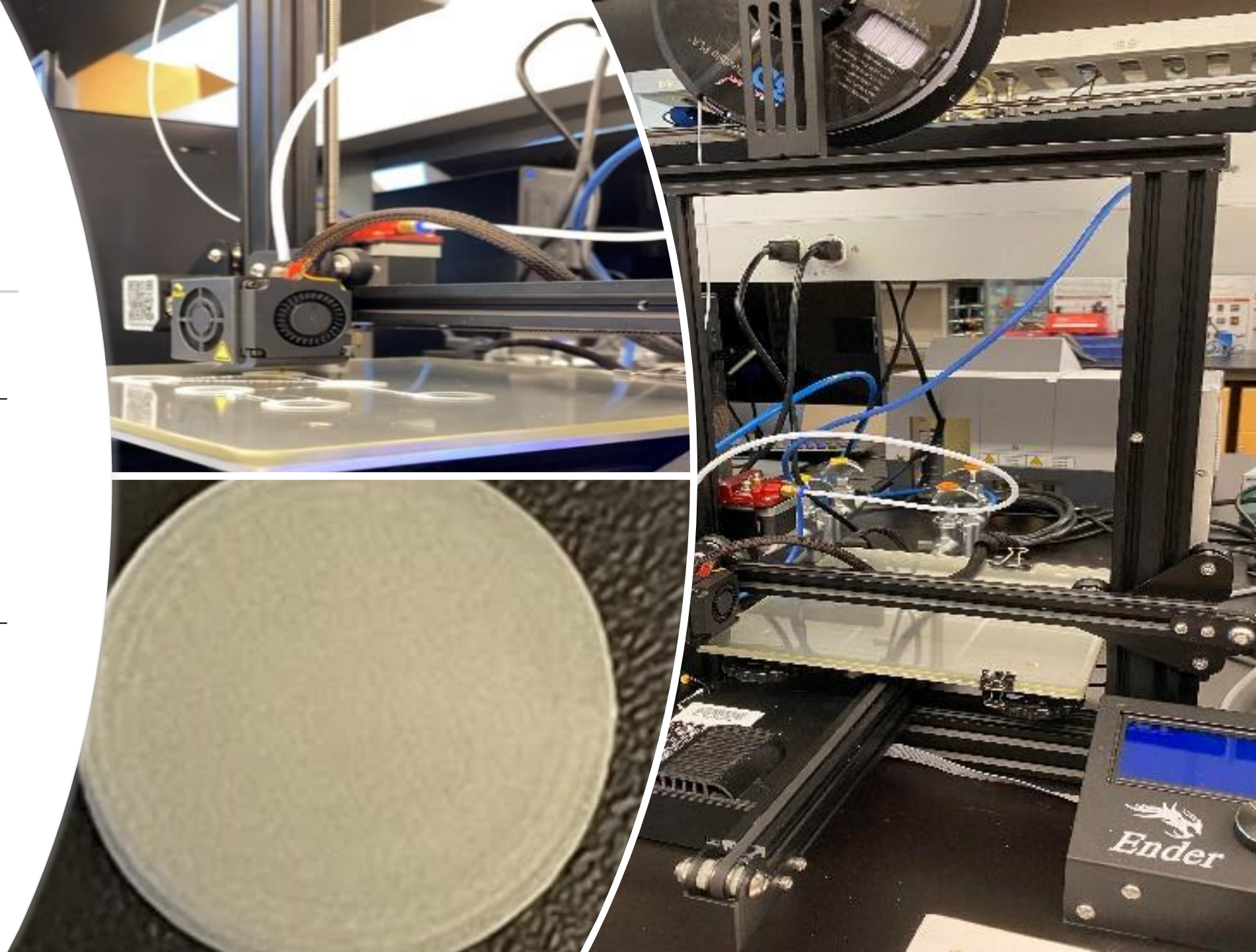
Methodology:

- Creating the PLA sample and treating them with Plasma from 1.2kV to 2.2kV.

- Using surface analysis software to analyze the surface and conclude the findings.

3D Printer

Speed	95 mm/s
Nozzle Temperature	215 ^{0}C
Bed Temperature	65 ^{0}C
Fan Speed	255 mm/s
Flow Rate	180 mm^3/s

High Voltage Plasma Treatment of Printed PLA sample:

- Figure 1: Plasma Treatment of Soft PLA sample

- Figure 2: Set up for High Voltage Plasma Treatment (Corona Discharge Plasma)

- Soft PLA samples are created and are Plasma treated from 1.2kV to 2.2 kV.
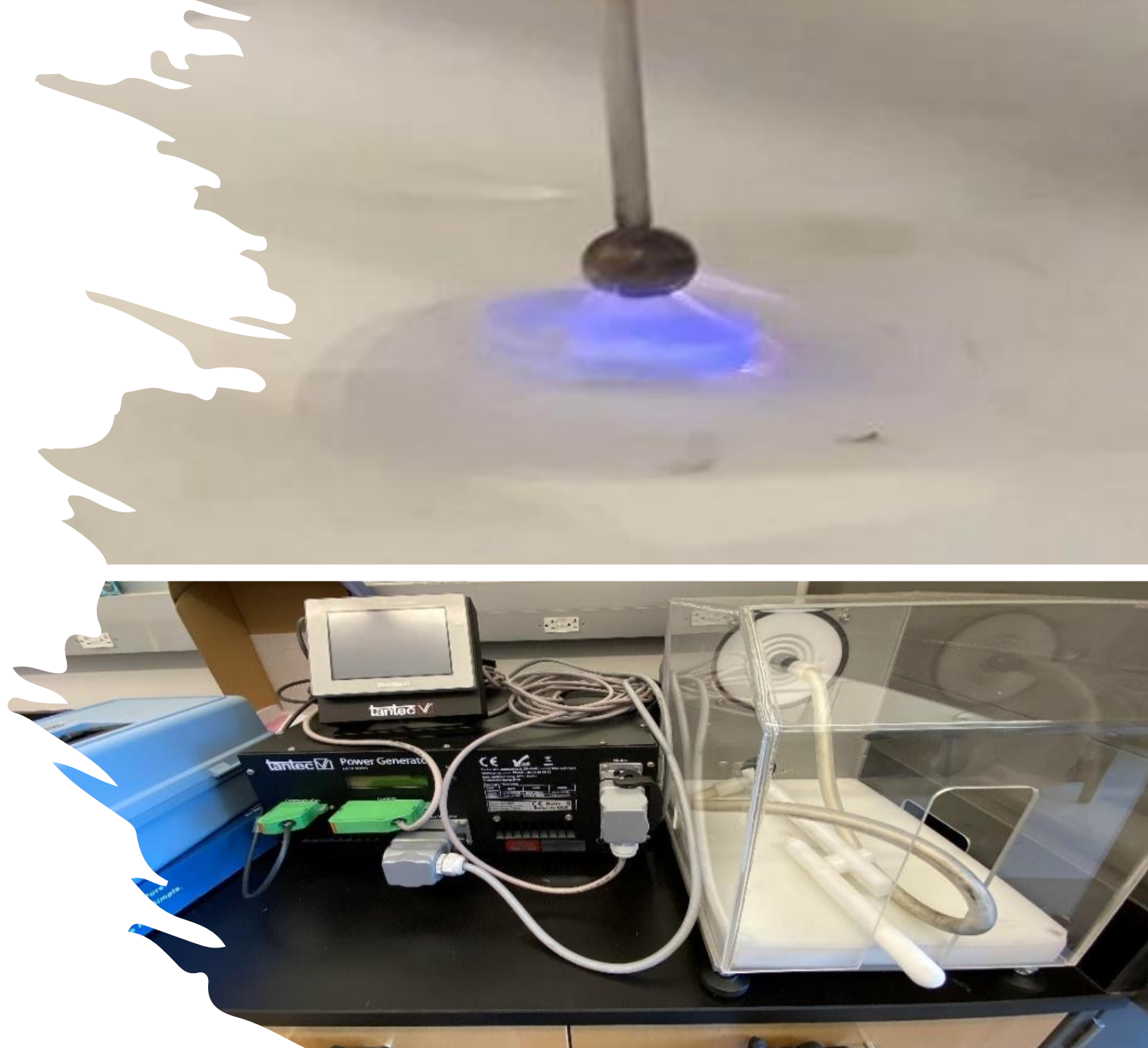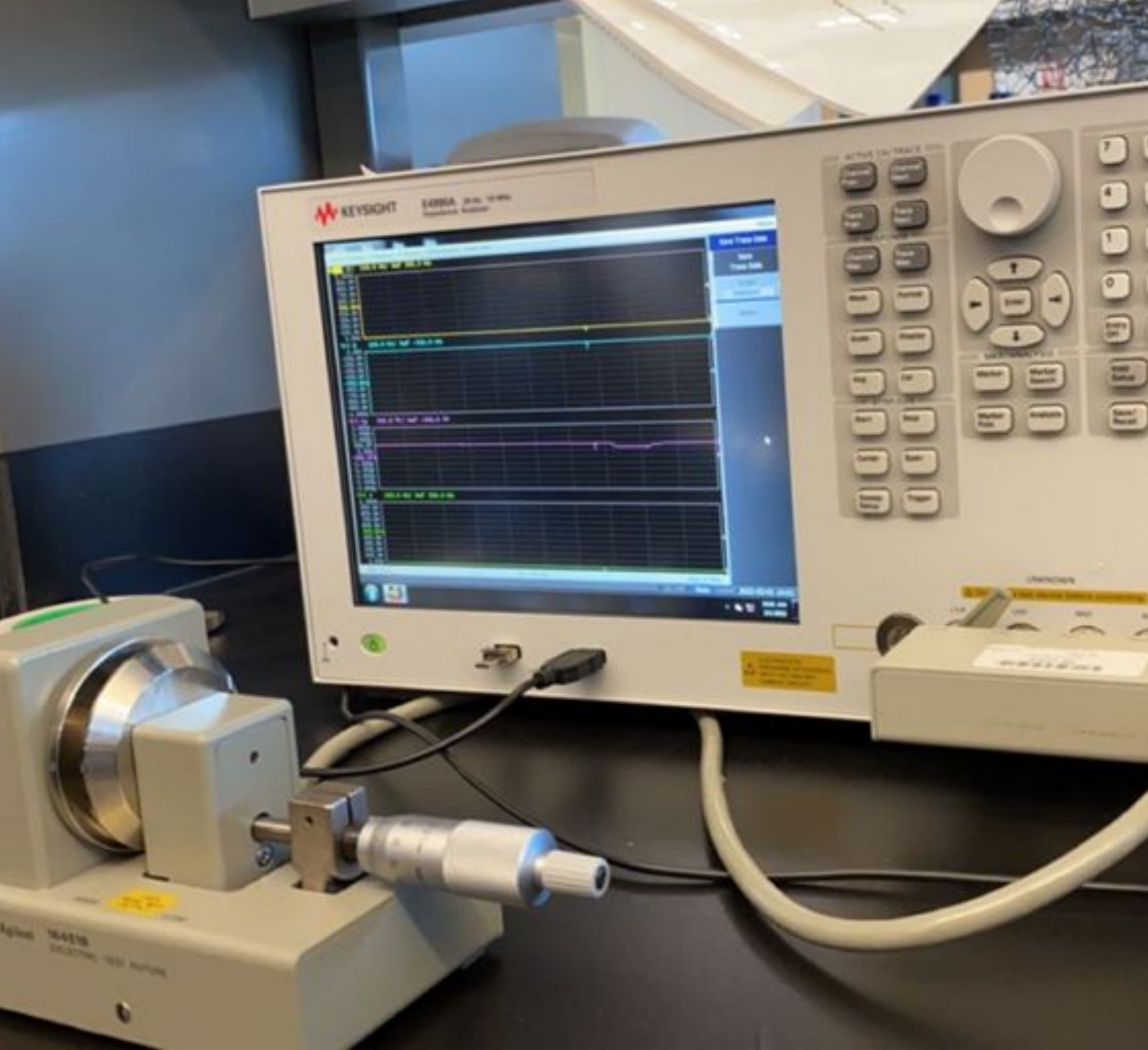
Impedance Analyzer:

For the analysis purpose the data is collected and combined for different timing samples and after that average and the standard deviation are calculated and an impedance versus voltage scatter plot is created.

Used to measure :

Impedance
Conductance
Resistance
Capacitance

Table Sample Impedance Data of 45 sec Plasma Treated PLA sample from 1.2 Kv to 2.2 Kv

| Sr. No	1.2	1.4	1.6	1.8	2.00	2.2
1	2.07E+09	2.31E+09	2.99E+09	3.26E+09	1.16E+09	2.00E+09
2	7.44E+06	7.62E+06	7.58E+06	8.29E+06	6.96E+06	6.83E+06
3	3.75E+06	3.83E+06	3.82E+06	4.17E+06	3.51E+06	3.43E+06
4	2.50E+06	2.56E+06	2.56E+06	2.79E+06	2.35E+06	2.29E+06
.	1.88E+06	1.92E+06	1.92E+06	2.10E+06	1.76E+06	1.72E+06
.	1.51E+06	1.54E+06	1.54E+06	1.68E+06	1.41E+06	1.38E+06
.	1.26E+06	1.29E+06	1.28E+06	1.40E+06	1.18E+06	1.15E+06
.	1.08E+06	1.10E+06	1.10E+06	1.20E+06	1.01E+06	9.87E+05
1605	9.44E+05	9.66E+05	9.64E+05	1.05E+06	8.86E+05	8.64E+05

Profilometer

Lens used: Nikon 50x DI.

The purpose of profilometry is to get surface morphology, step heights and surface roughness.
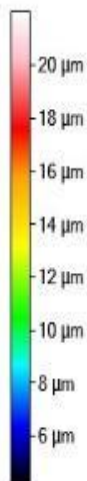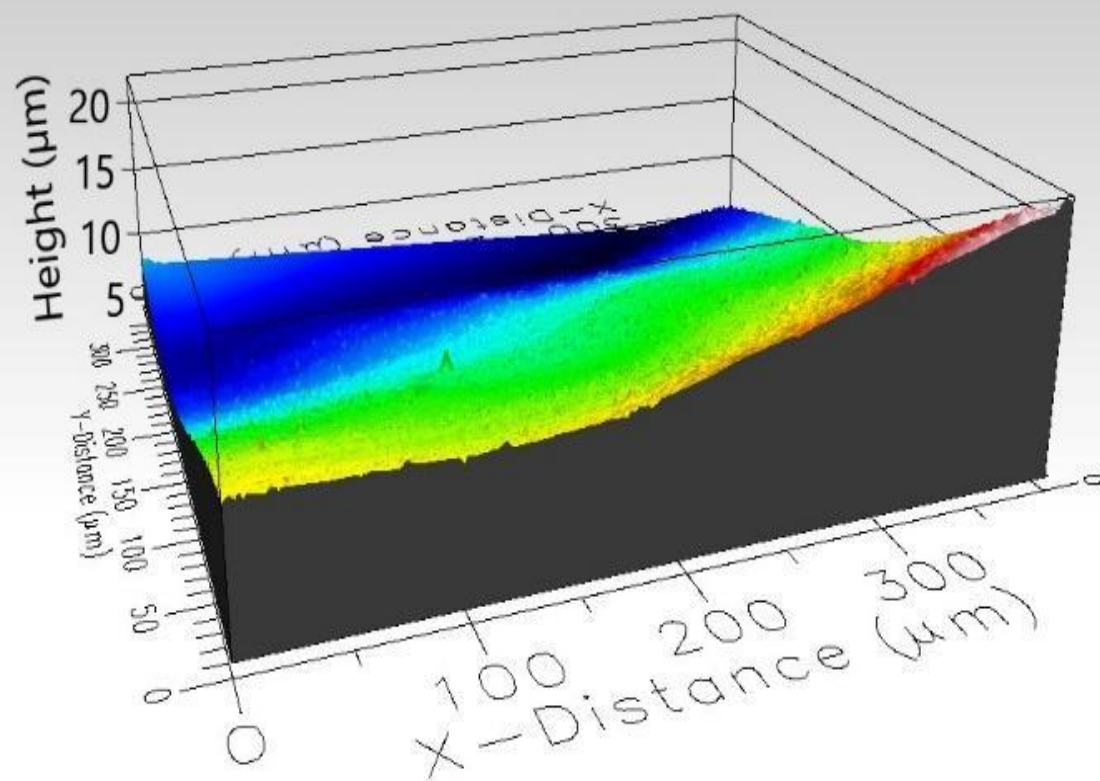
Top View
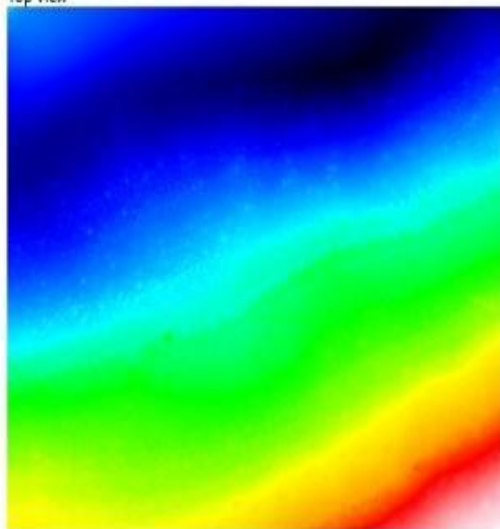
3D View

Area Roughness

Area of Interest

Select Entire image, or select Restricted area and drag yellow box in Top View to specify the area of interest

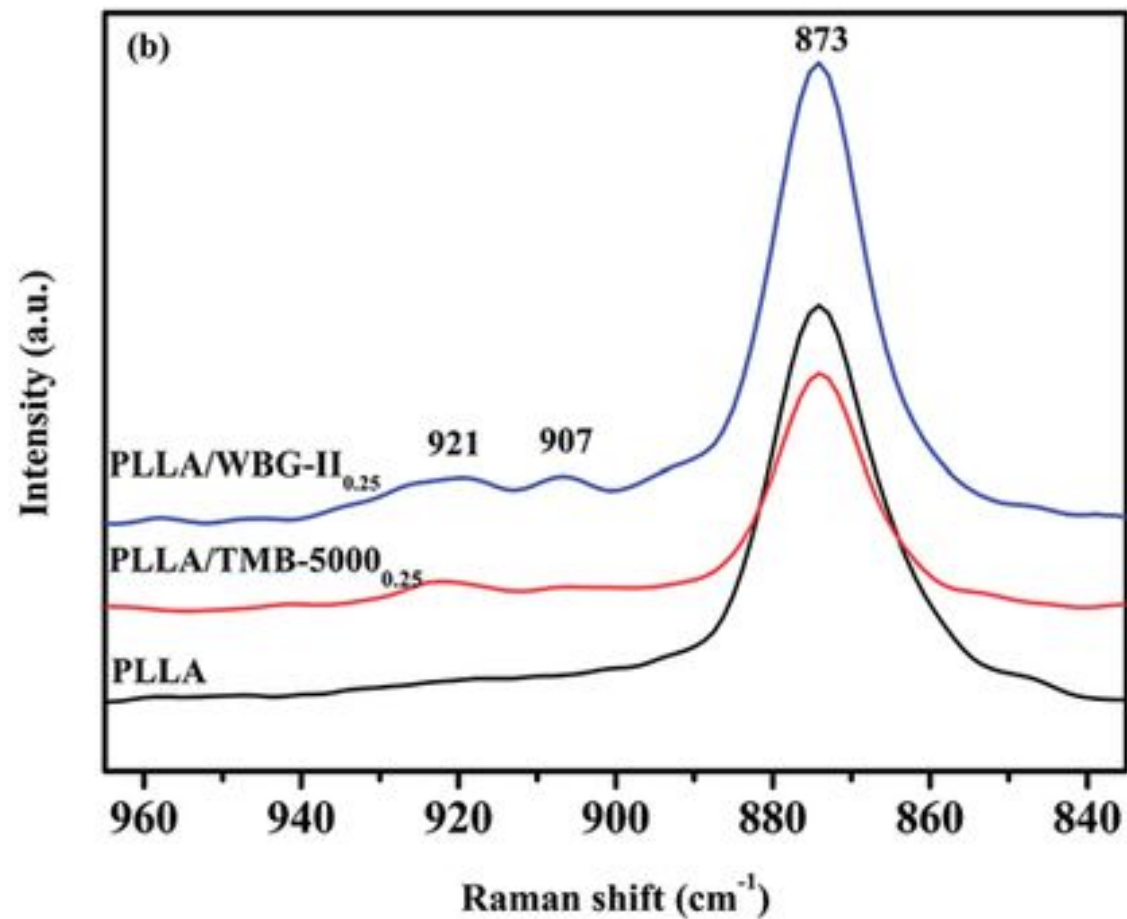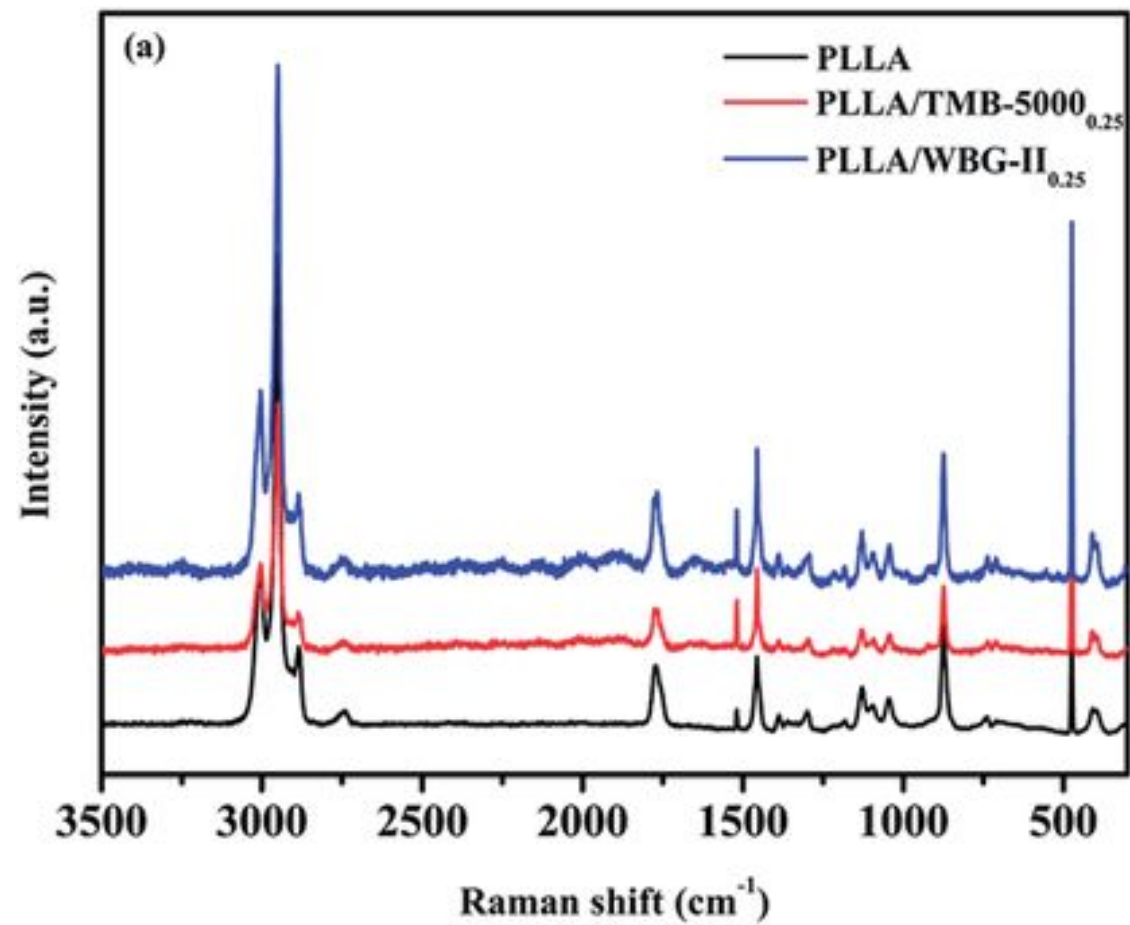◉ Entire image ◯ Restricted area

Width: ____ µm Height: ____ µm

Settings...

Area Roughness

⌄ General			
Average	9.251	µm	Mean height
Minimum	4.197	µm	Minimum height
Maximum	22	µm	Maximum height
Range	17.8	µm	Maximum - Minimum
⌄ ASME B46.1 3D			
Sp	12.75	µm	Peak height
Sv	5.054	µm	Valley depth
St	17.8	µm	Maximum peak to valley height
Sa	2.733	µm	Arithmetic mean height
Sq	3.362	µm	Root mean square height
Ssk	0.8351		Skewness
Sku	3.417		Kurtosis
⌄ EUR 15178N Amplitude			
Sp	12.75	µm	Maximum peak height
Sv	5.054	µm	Maximum pit height
St	17.8	µm	Maximum height
Sa	2.733	µm	Arithmetic mean height
Sq	3.362	µm	Root mean square height
Ssk	0.8351		Skewness
Sku	3.417		Kurtosis
⌄ ISO 25178 Height			
Sp	12.75	µm	Maximum peak height
Sv	5.054	µm	Maximum pit height
Sz	17.8	µm	Maximum height
Sa	2.733	µm	Arithmetic mean height
Sq	3.362	µm	Root mean square height
Ssk	0.8351		Skewness
Sku	3.417		Kurtosis

20 µm
18 µm
16 µm
14 µm
12 µm
10 µm
8 µm
6 µm

Height (µm)

Y-Distance (µm)

X-Distance (µm)

Raman Spectroscopy:

Conclusion & Future Goals:

- Understanding the surface modification process and analysing the created samples.
- Using different types of machines and learn its application.
- Creation of SOP for the analysis machines/instruments.
- Implemented cuvette cleaning processes in the lab

Q & A

- If you have any further questions, or if you would like to discuss more about my project kindly contact me via

  email:pskhane21@mail.fresnostate.edu

Thank You!