MM 203

Photonic CRYSTALS

CHARACTERISATION

INTRODUCTION

Photonic crystals are a class of optical materials that exhibit a periodic structure on the scale of the wavelength of light.The periodic arrangement of dielectric materials in photonic crystals leads to the creation of allowed and forbidden energy bands for photons. Photons within the allowed bands can propagate through the crystal, while those within the forbidden bands are prohibited from doing so, resulting in a photonic band gap. This unique property enables precise control of light in various applications, such as optical communication, sensors, lasers, and even in the development of novel optical devices.

PREPARATION STEPS

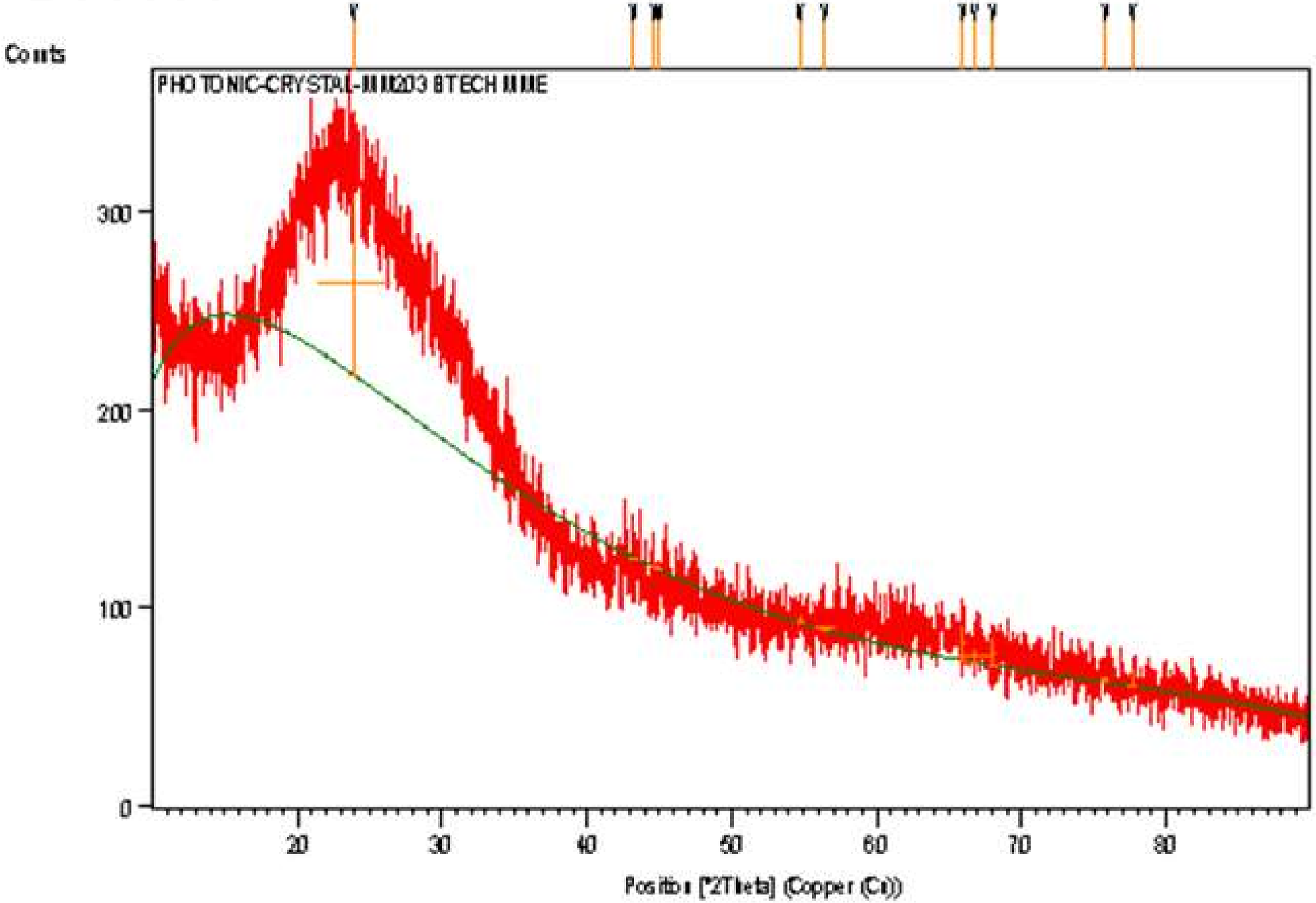
- 4 wt% of polystyrene beads suspension was prepared in DI water.
- Sonication was done to disperse the suspension and separate the aggregation of nanospheres.
- The microscopic slides were used as base substrate and they were cleaned using soap, ethanol and then piranha solution to remove any organic remnants and make the surface hydrophilic.
- The slides were then immersed in the polystyrene solution and hold for 2 minutes.
- Finally the sample was kept in oven at 80 degree C for 30min for drying and self assembly.
- The steps were repeated for 2 more samples at 3 minutes and 5 minutes.

XRD DATA

Anchor Scan Parameters

Dataset Name: PHOTONIC-CRYSTAL-MM203 BTECH MME
File name: C:\X'Pert Data\PHOTONIC-CRYSTAL-MM203 BTECH MME.xrdml
Comment: Configuration=Flat Sample Stage, Owner=User-1, Creation date=6/4/2010 2:27:02 PM
Goniometer=PW3050/60 (Theta/Theta); Minimum step size 2Theta:0.001; Minimum step size Omega:0.001
Sample stage=PW3071/xx Bracket
Diffractometer system=XPERT-PRO
Measurement program=material+mech, Owner=User-1, Creation date=9/5/2018 3:29:17 PM
Measurement Date / Time: 11/8/2018 4:56:44 PM
Operator: amit
Raw Data Origin: XRD measurement (*.XRDML)
Scan Axis: Gonio
Start Position [°2Th.]: 10.0114
End Position [°2Th.]: 89.9794
Step Size [°2Th.]: 0.0170
Scan Step Time [s]: 50.1650
Scan Type: Continuous
PSD Mode: Scanning
PSD Length [°2Th.]: 2.12
Offset [°2Th.]: 0.0000
Divergence Slit Type: Fixed
Divergence Slit Size [°]: 1.7359
Specimen Length [mm]: 10.00
Measurement Temperature [°C]: 25.00
Anode Material: Cu
K-Alpha1 [Å]: 1.54060
K-Alpha2 [Å]: 1.54443
K-Beta [Å]: 1.39225
K-A2 / K-A1 Ratio: 0.50000
Generator Settings: 40 mA, 45 kV
Diffractometer Type: 00000000011075742
Diffractometer Number: 0
Goniometer Radius [mm]: 240.00
Dist. Focus-Diverg. Slit [mm]: 100.00
Incident Beam Monochromator: No
Spinning: No

XRD DATA


Counts
PHOTONIC-CRYSTAL-MIL203 BTECH MME
300
200
100
0
20
30
40
50
60
70
80
Position [°2Theta] (Copper (Cu))

XRD DATA

Peak List

Pos.[°2Th.]	Height [cts]	FWHM Left[°2Th.]	d-spacing [Å]	Rel. Int. [%]
23.858290	93.008800	5.098811	3.72662	100.00
43.256380	0.001000	0.001000	2.08990	0.00
44.622740	0.001000	0.001000	2.02903	0.00
45.006190	0.001000	0.001000	2.01263	0.00
54.739490	3.898109	0.227509	1.67554	4.19
56.380880	2.667017	1.302631	1.63059	2.87
65.964310	17.935380	0.072298	1.41501	19.28
66.736970	7.029620	2.592071	1.40049	7.56
68.048800	13.785360	0.057607	1.37665	14.82
75.815160	2.670715	0.521051	1.25376	2.87
77.686280	8.346387	0.122767	1.22817	8.97

XRD DATA

Pos.[°2Th.]	sin(θ)	Possible Miller indices (hkl)
23.858290	0.163984	(2,1,1)
43.256380	0.087647	(5,2,2)
44.622740	0.084946	(5,2,2)
45.006190	0.084088	(5,2,2)
54.739490	0.064399	(7,2,2)
56.380880	0.062819	(7,2,2)
65.964310	0.049364	(9,3,3)
66.736970	0.048640	(9,3,3)
68.048800	0.047498	(9,3,3)
75.815160	0.038402	(11,3,3)
77.686280	0.037680	(11,3,3)

XRD DATA

2dsin(theta)=n(lemda)

Using the equation, we can calculate the Miller indices:

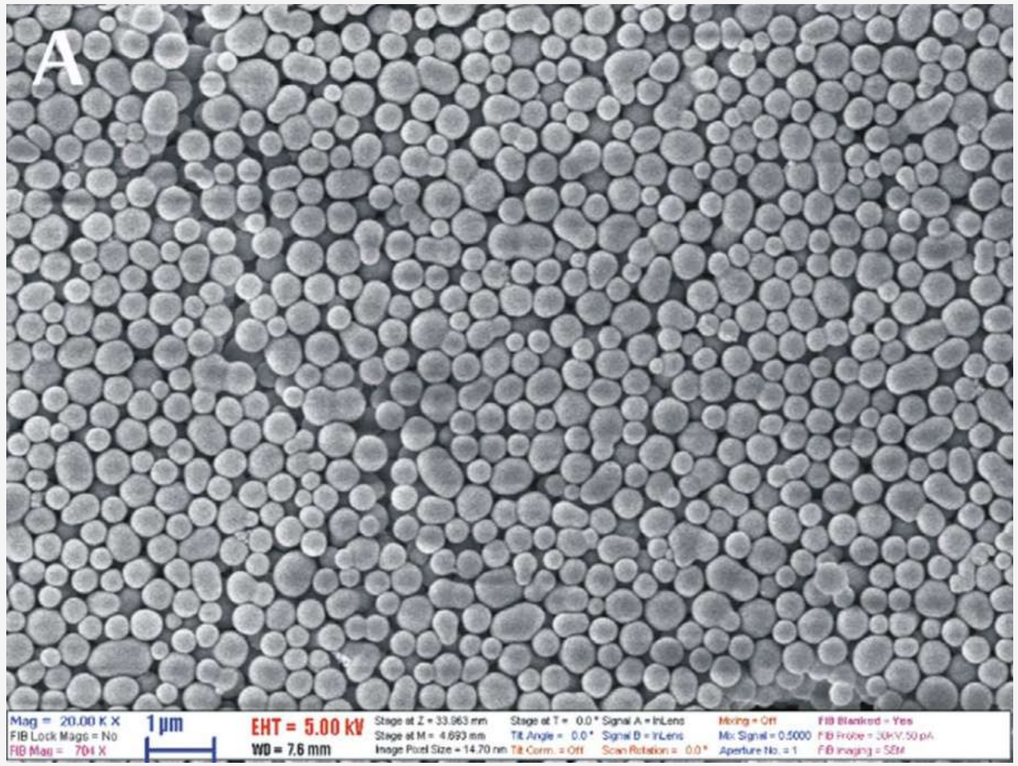
Miller indices (hkl)
(2,1,1)

d-spacing (nm)
3.42

RESULTS

- It is a amorphous nature but the indices are consistent with a BCC crystal structure.
- The crystallite size of polystyrene nanospheres is around 3.42nm

SEM IMAGES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FIB Mag = 704 X
1 µm
EHT = 5.00 kV
WD = 7.6 mm
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Stage at M = 4.693 mm
Image Pixel Size = 14.70 nm
Stage at T = 0.0 °
Tilt Angle = 0.0 °
Tilt Corrn. = Off
Signal A = InLens
Signal B = InLens
Scan Rotation = 0.0 °
Mixing = Off
Mix Signal = 0.5000
Aperture No. = 1
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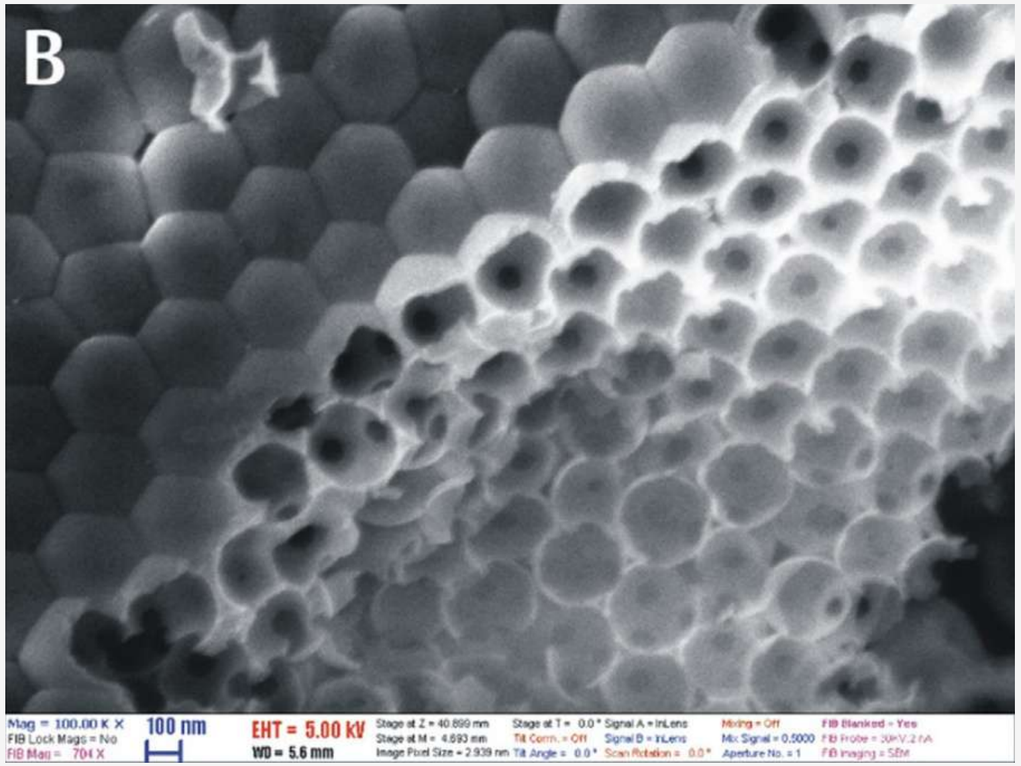
FIB Probe = 30kV,50 pA
FIB Imaging = SEM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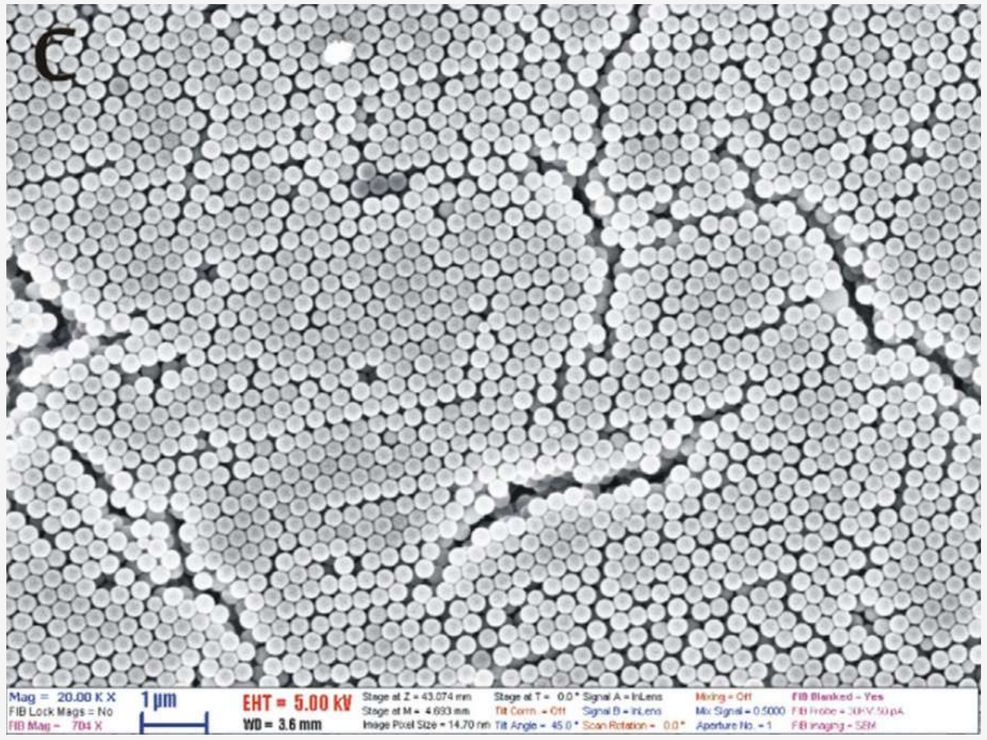
FIB Mag = 704 X
100 nm
EHT = 5.00 kV
WD = 5.6 mm
Stage at Z = 40.899 mm
Stage at M = 4.693 mm
Image Pixel Size = 2.939 nm
Stage at T = 0.0 °
Tilt Angle = 0.0 °
Tilt Corrn. = Off
Signal A = InLens
Signal B = InLens
Scan Rotation = 0.0 °
Mixing = Off
Mix Signal = 0.5000
Aperture No. = 1
FIB Blanked = Yes
FIB Probe = 30kV,2 nA
FIB Imaging = SEM

SEM IMAGES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FIB Mag = 704 X
1 µm
EHT = 5.00 kV
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Stage at M = 4.693 mm
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Tilt Corrn. = Off
Tilt Angle = 45.0 °
Signal B = InLens
Scan Rotation = 0.0 °
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Mix Signal = 0.5000
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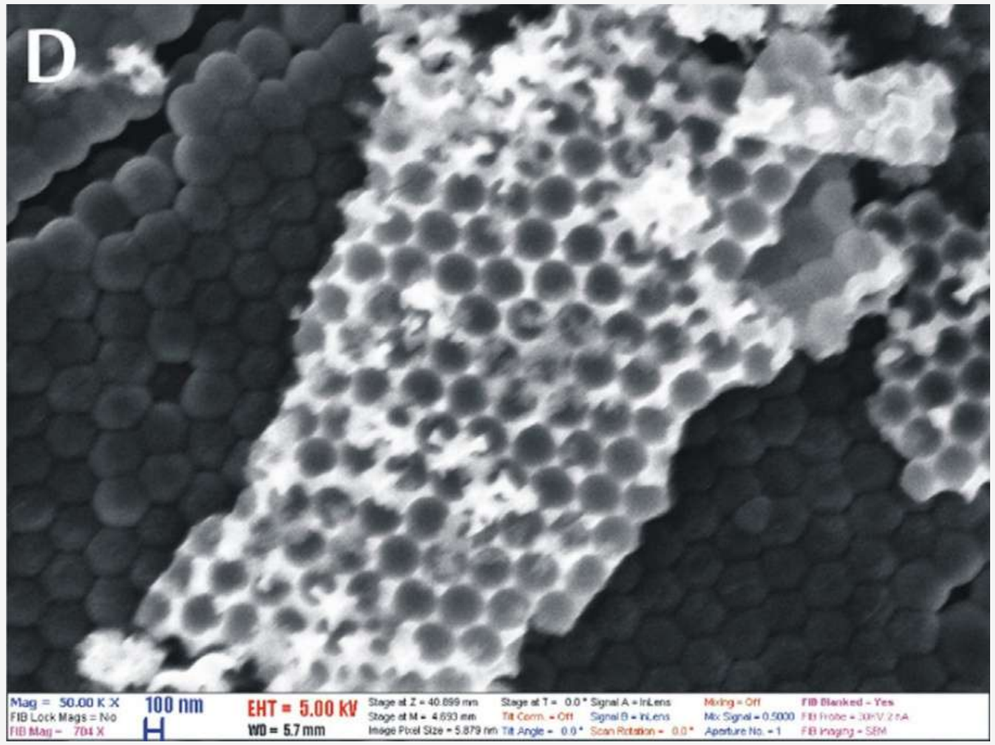
FIB Blanked = Yes
FIB imaging = SEM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Mag = 50.00 K X
FIB Lock Mags = No
FIB Mag = 704 X
100 nm
EHT = 5.00 kV
WD = 5.7 mm
Stage at Z = 40.899 mm
Stage at M = 4.693 mm
Image Pixel Size = 5.879 nm
Stage at T = 0.0 ° Signal A = InLens
Tilt Corrn. = Off
Tilt Angle = 0.0 °
Signal B = InLens
Scan Rotation = 0.0 °
Mixing = Off
Mix Signal = 0.5000
Aperture No. = 1
FIB Blanked = Yes
FIB imaging = SEM

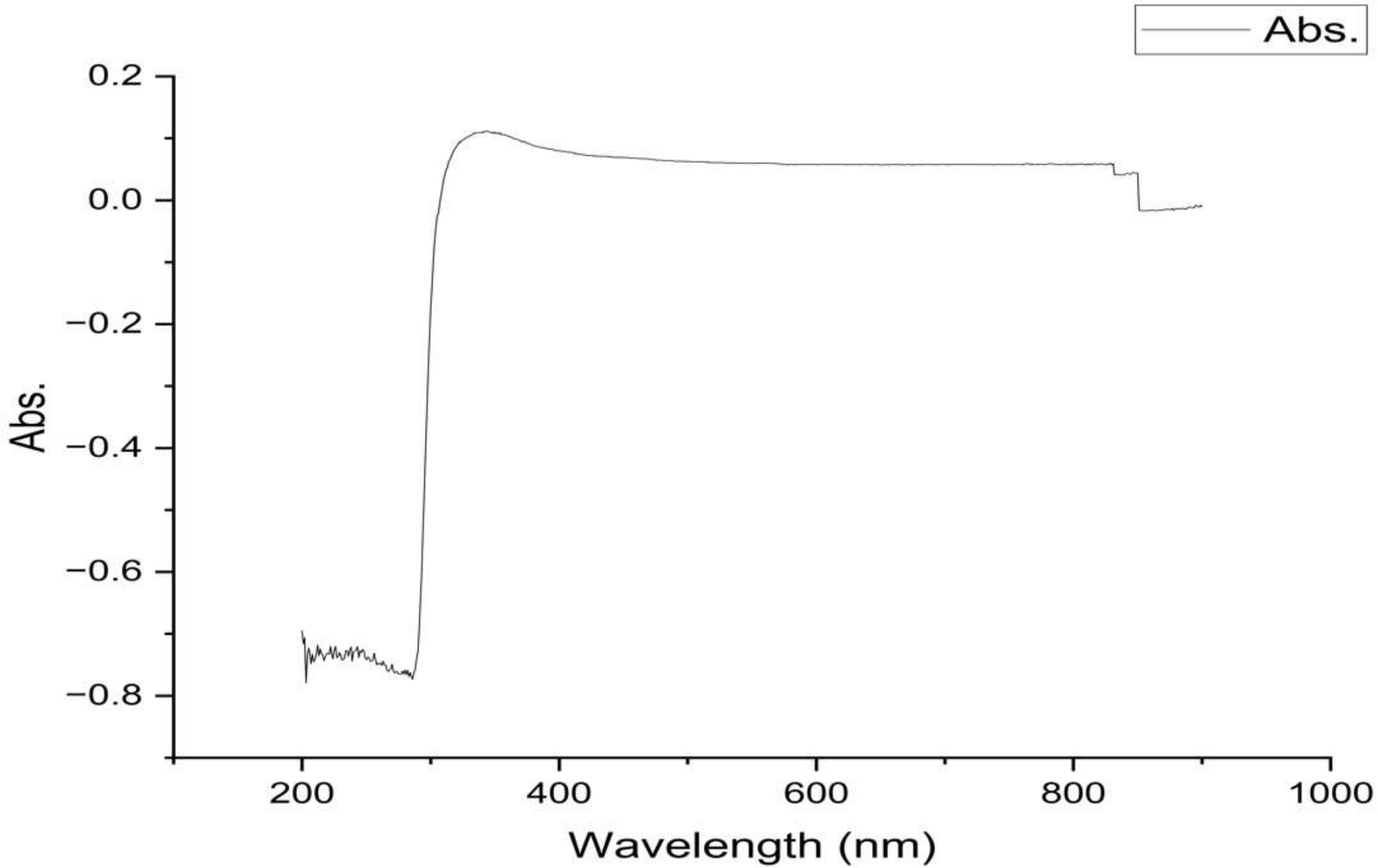
UV-VIS SPECTROMETRY

PRACTICAL DATA OF UV-VIS CHARACTERIZATION OF PHOTONIC CRYSTAL

1	slit - RawData	
2	Wavelength nm.	Abs.
3	200	-0.695
4	201	-0.716
5	202	-0.706
6	203	-0.779
7	204	-0.736
8	205	-0.723
9	206	-0.732
10	207	-0.748
11	208	-0.733
12	209	-0.745
13	210	-0.741
14	211	-0.733
15	212	-0.718
16	213	-0.735
17	214	-0.724
18	215	-0.732
19	216	-0.733
20	217	-0.743
21	218	-0.737
22	219	-0.732
23	220	-0.731
24	221	-0.733
25	222	-0.72
26	223	-0.731
27	224	-0.74
28	225	-0.726
29	226	-0.72
30	227	-0.738
31	228	-0.737
32	229	-0.73
33	230	-0.735
34	231	-0.742
35	232	-0.742
36	233	-0.738
37	234	-0.727
38	235	-0.727
39	236	-0.736
40	237	-0.725
41	238	-0.721
42	239	-0.744
43	240	-0.729
44	241	-0.728
45	242	-0.726
46	243	-0.72
47	244	-0.738
48	245	-0.727
49	246	-0.73
50	247	-0.725
51	248	-0.726
52	249	-0.738
53	250	-0.742
54	251	-0.737
55	252	-0.739
56	253	-0.744
57	254	-0.744
58	255	-0.743
59	256	-0.731
60	257	-0.74
61	258	-0.75
62	259	-0.747
63	260	-0.748
64	261	-0.747
65	262	-0.751
66	263	-0.744
67	264	-0.75
68	265	-0.75
69	266	-0.759
70	267	-0.761
71	268	-0.758
72	269	-0.756
73	270	-0.749
74	271	-0.759
75	272	-0.763
76	273	-0.761
77	274	-0.761
78	275	-0.765
79	276	-0.765
80	277	-0.765
81	278	-0.76
82	279	-0.765
83	280	-0.758
84	281	-0.766
85	282	-0.758
86	283	-0.769
87	284	-0.762
88	285	-0.77
89	286	-0.773
90	287	-0.762

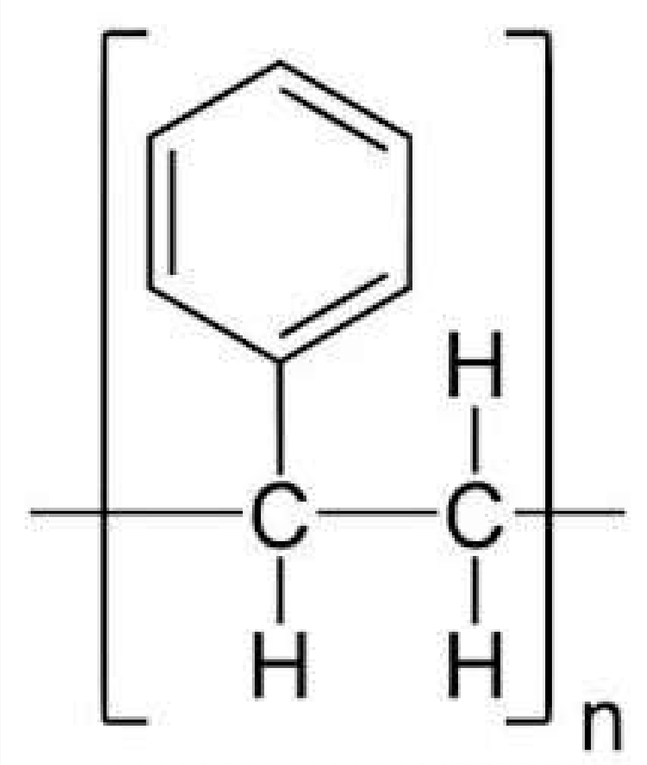
UV-VIS SPECTROMETRY

GRAPH OF ABOVE DATA FOR UV-VIS CHARACTERIZATION



UV-VIS SPECTROMETRY

RESULTS:
From the graph, we conclude that our sample is almost transparent with little absorbance throughout the spectrum.




MM 203
THANK YOU