

Figure 1.

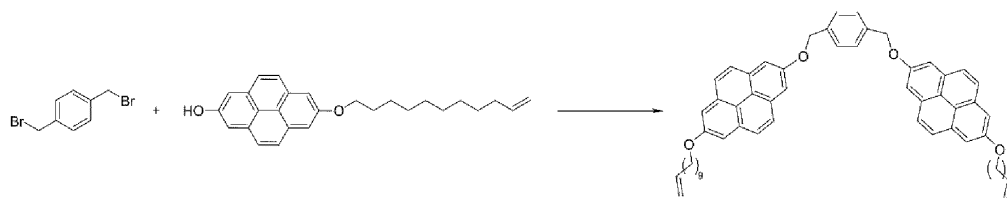


Figure 2.

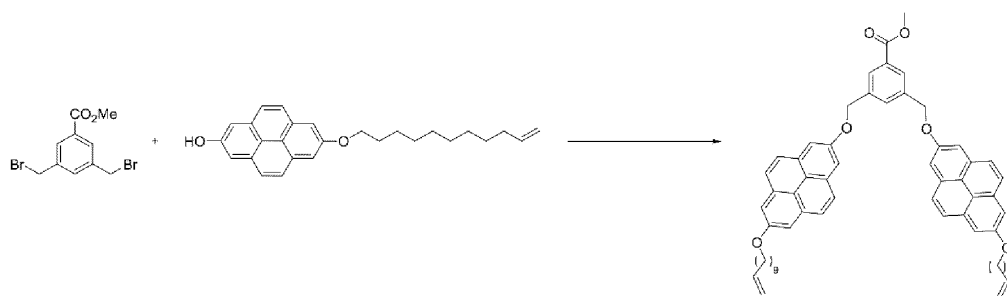


Figure 3.

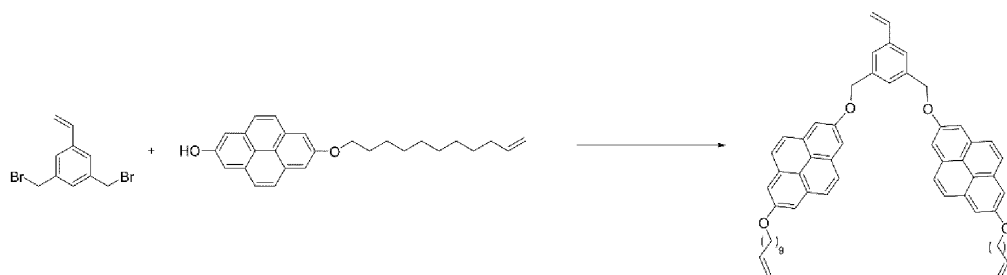


Figure 4.

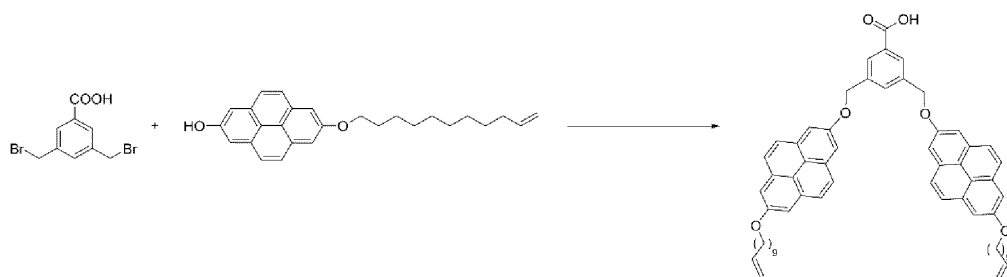


Figure 5.

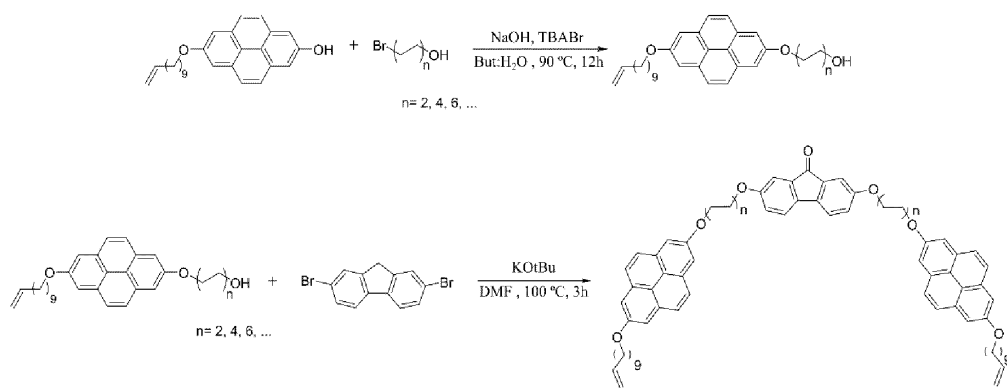


Figure 6.

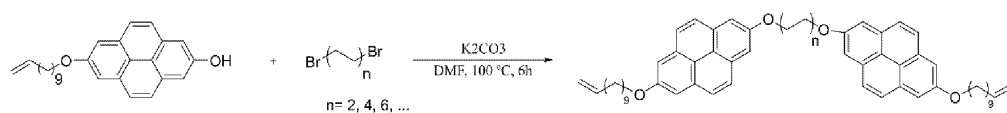


Figure 7.

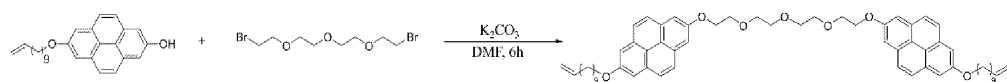


Figure 8.

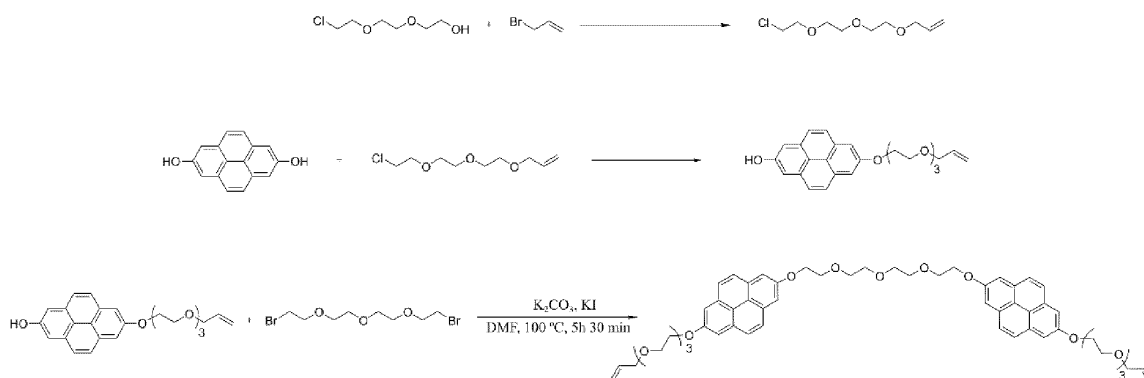


Figure 9.

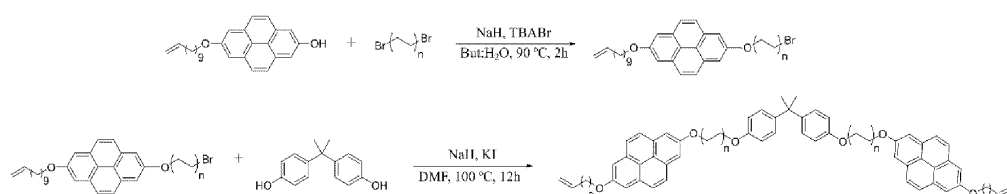


Figure 10.

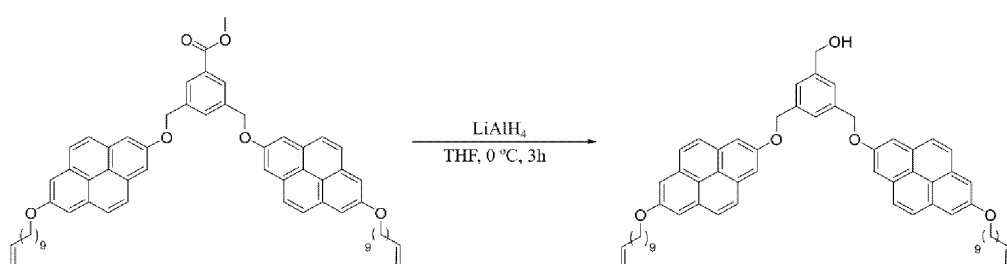


Figure 11.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
335k_PS-NH ₂ ester MINT_1:1	3942.78	24.62
921k_PS-NH ₂ ester MINT_1:1	3055.98	27.92
3,530k_PS-NH ₂ ester MINT_1:1	2780.82	22.58
335k_PS-NH ₂ ester MINT_0.1	2862.51	22.25
921k_PS-NH ₂ ester MINT_0.1	2855.55	15.52
3,530k_PS-NH ₂ ester MINT_0.1	3020.35	24.30

Figure 12.

Sample	Young's Modulus (MPa)	Standard deviation
Neat_PMMA	2360.97	107.05
PMMA_Tuball_0.1	2665.69	418.4
PMMA_Tuball_1.0	1860.08	238.14
PMMA_Chain_0.1	3732.77	1115.97
PMMA_Chain_1.0	3423.32	277.7
PMMA_Glycol_0.1	2910.89	140.35
PMMA_Glycol_1.0	2868.87	503.55

Figure 13.

Sample	Young's Modulus (MPa)	Standard deviation
Neat_PVC	3235.51	-
PVC_Tuball_0.1	3515.42	191.3
PVC_Tuball_1.0	6694.85	236.2
PVC_Chain_0.1	3381.71	100.9
PVC_Chain_1.0	3672.11	31.2
PVC_Glycol_0.1	3970.43	500.7
PVC_Glycol_1.0	4119.14	61.5

Figure 14.

Sample	Young's Modulus (MPa)	Standard deviation
Neat_LDPE	322.18	16.25
LDPE_Tuball_0.1	332.51	36.16
LDPE_Tuball_1.0	343.32	28.75
LDPE_Chain_0.1	350.66	45.82
LDPE_Chain_1.0	342.32	28.75
LDPE_Glycol_0.1	406.44	88.03
LDPE_Glycol_1.0	449.68	91.14

Figure 15.

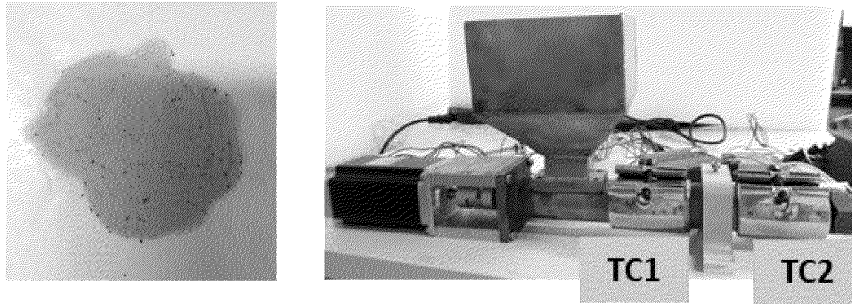


Figure 16.

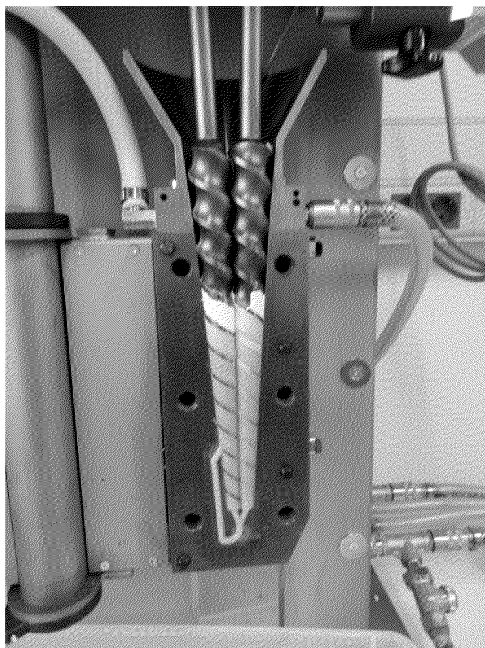


Figure 17.

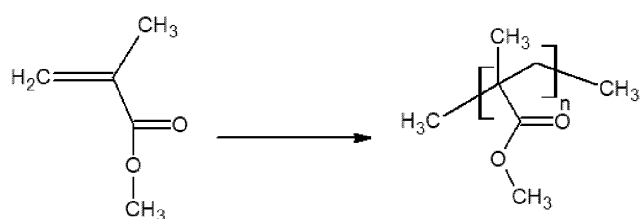


Figure 18.

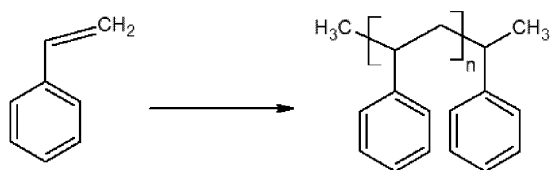


Figure 19.

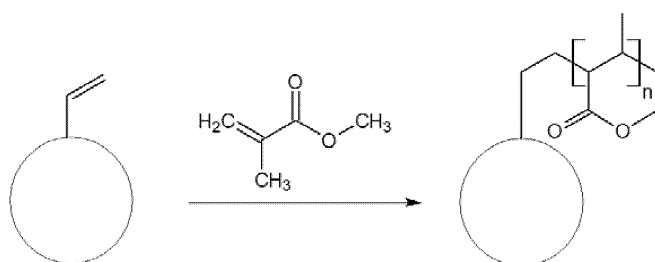


Figure 20.

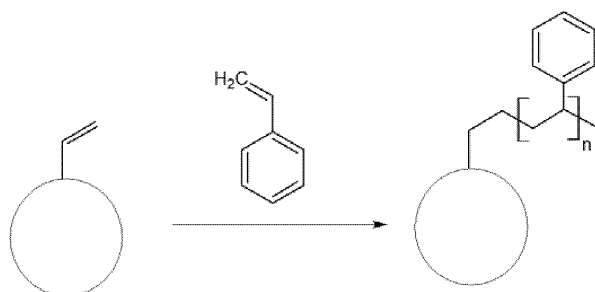


Figure 21.



Figure 22.

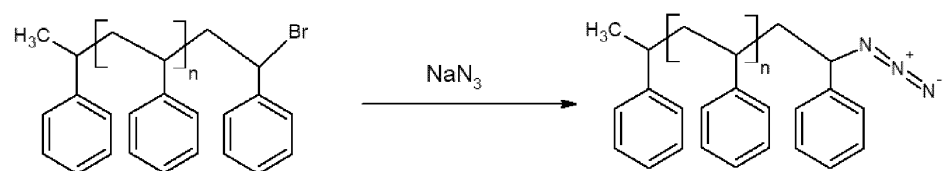


Figure 23.

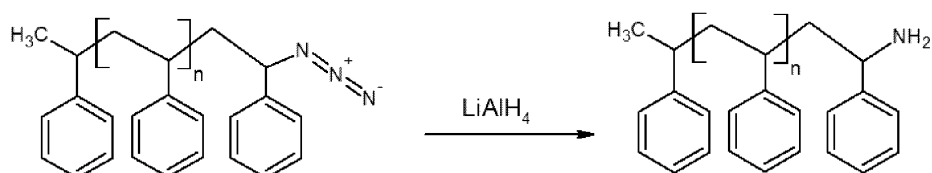


Figure 24.

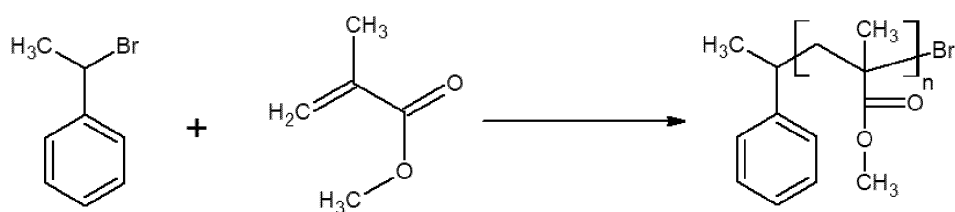


Figure 25.

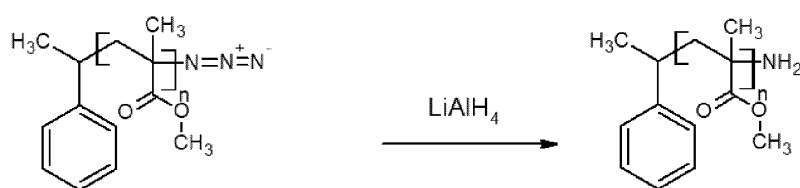


Figure 26.

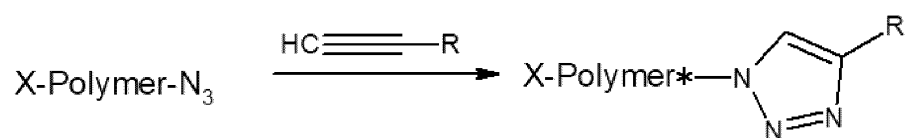


Figure 27.

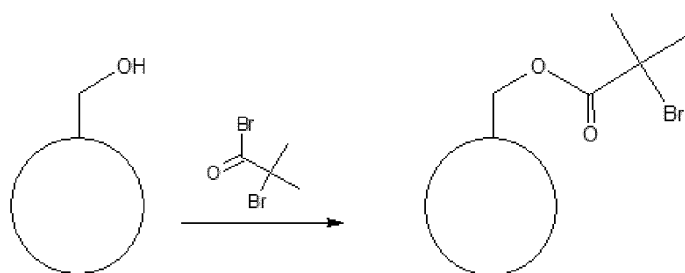


Figure 28.

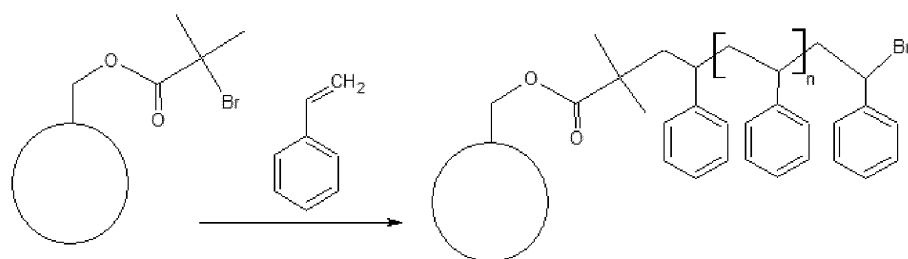


Figure 29.

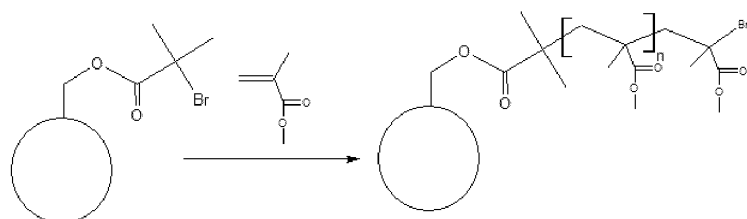


Figure 30.

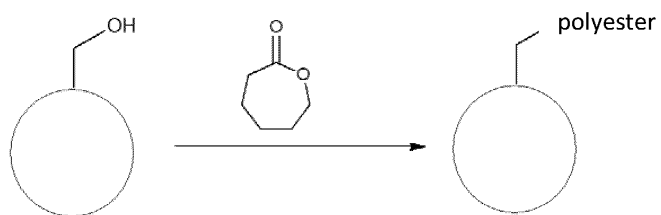
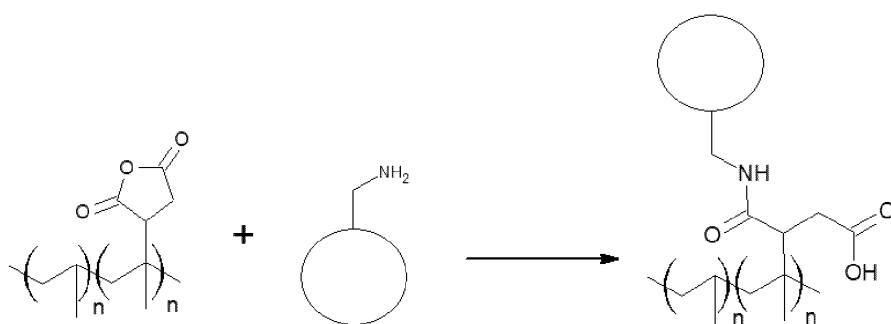


Figure 31.



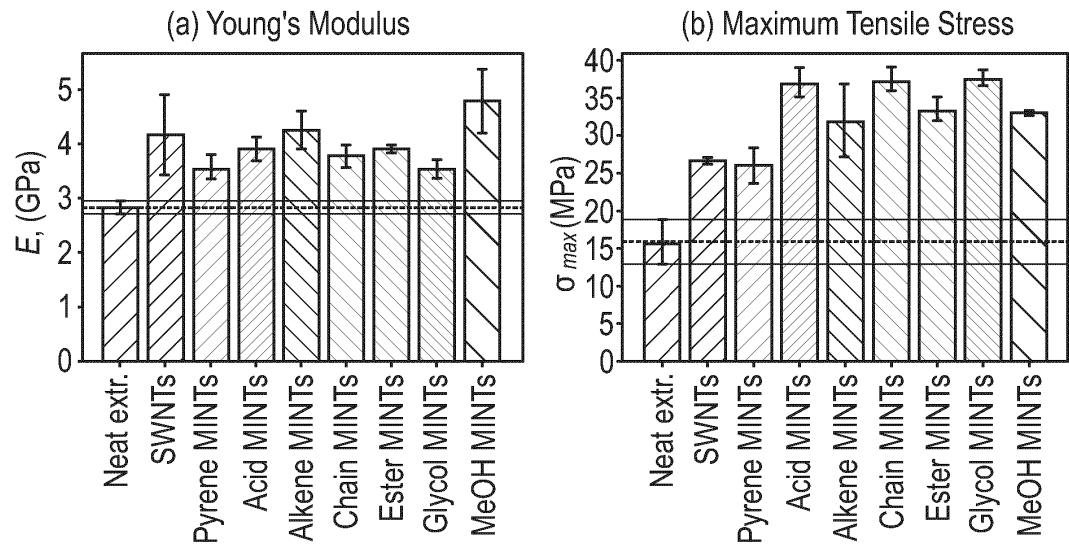


Figure 34 : 1% SWNTs composites with PLA

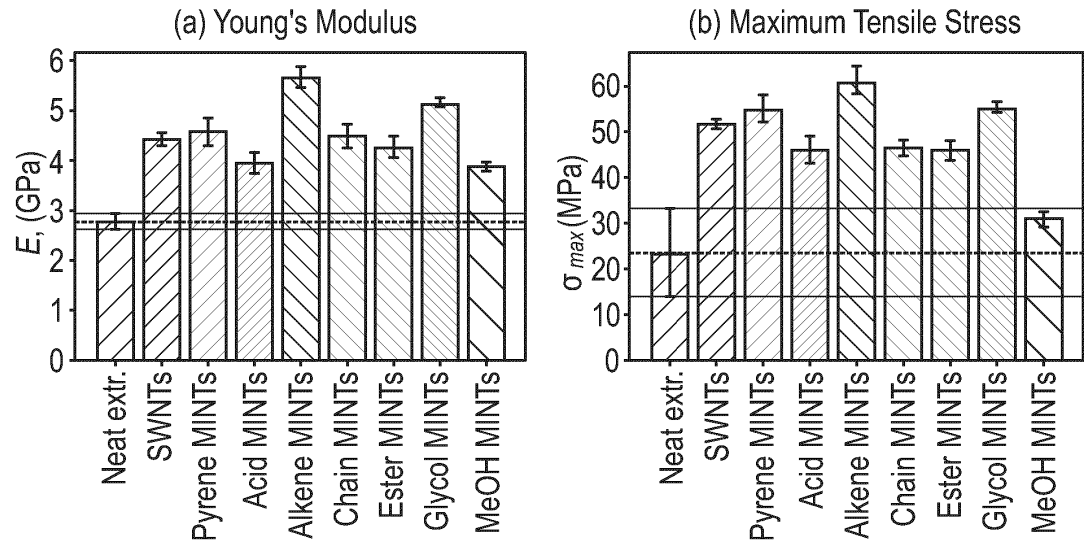


Figure 35 : 5% SWNTs composites with PLA

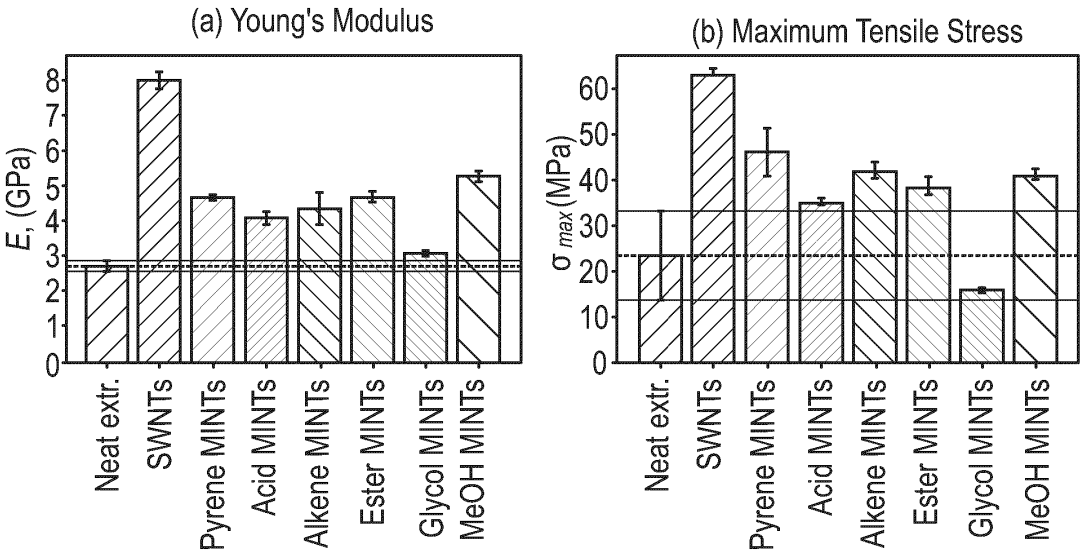


Figure 36 : 10% SWNTs composites with PLA

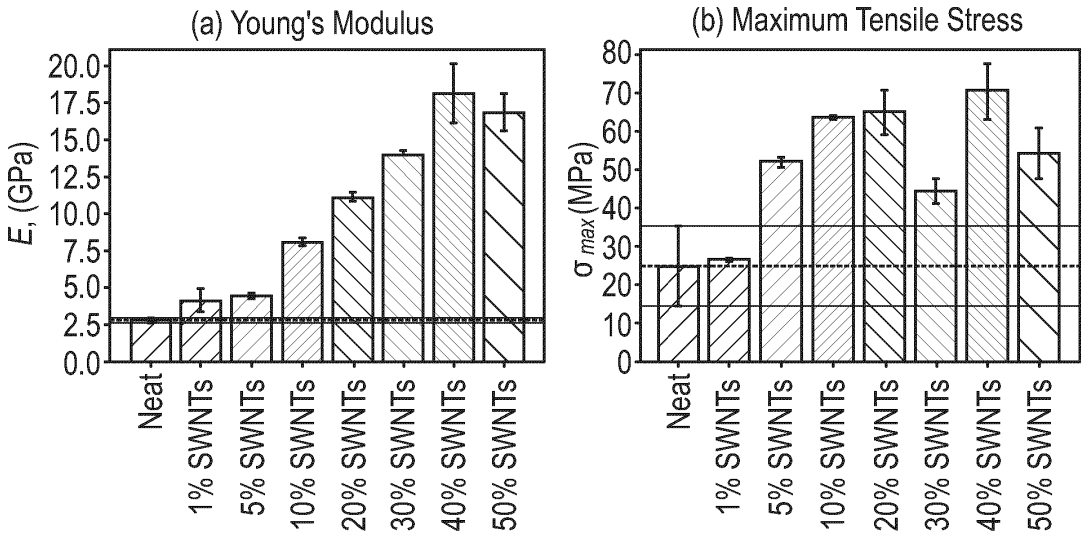


Figure 37, A : Different SWNTs content composites with PLA

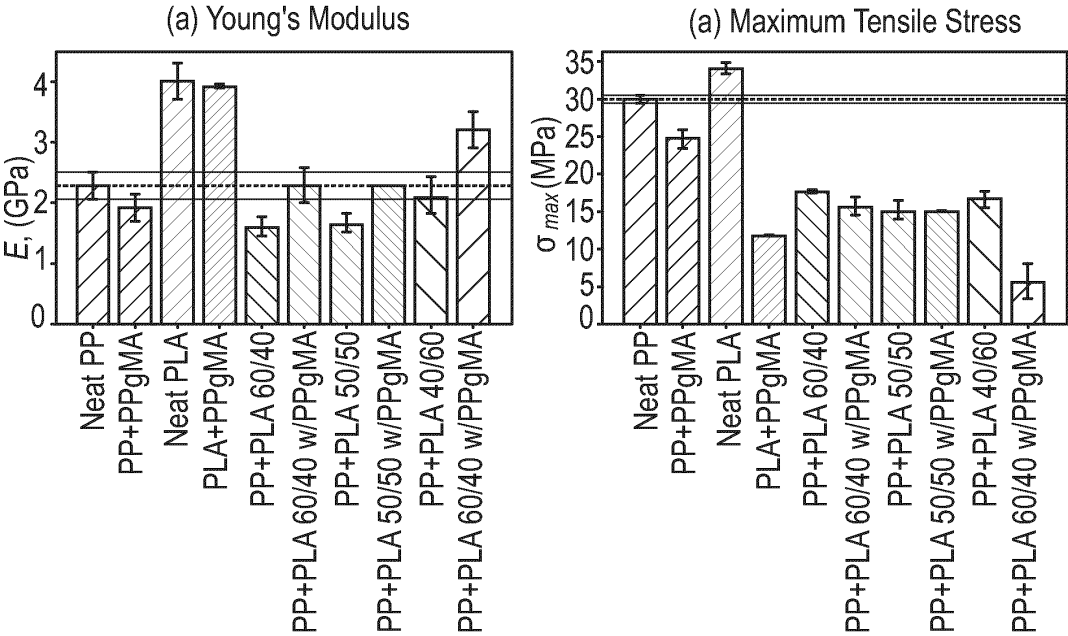


Figure 37, B : Different blends of PLA, PP and PPgMA

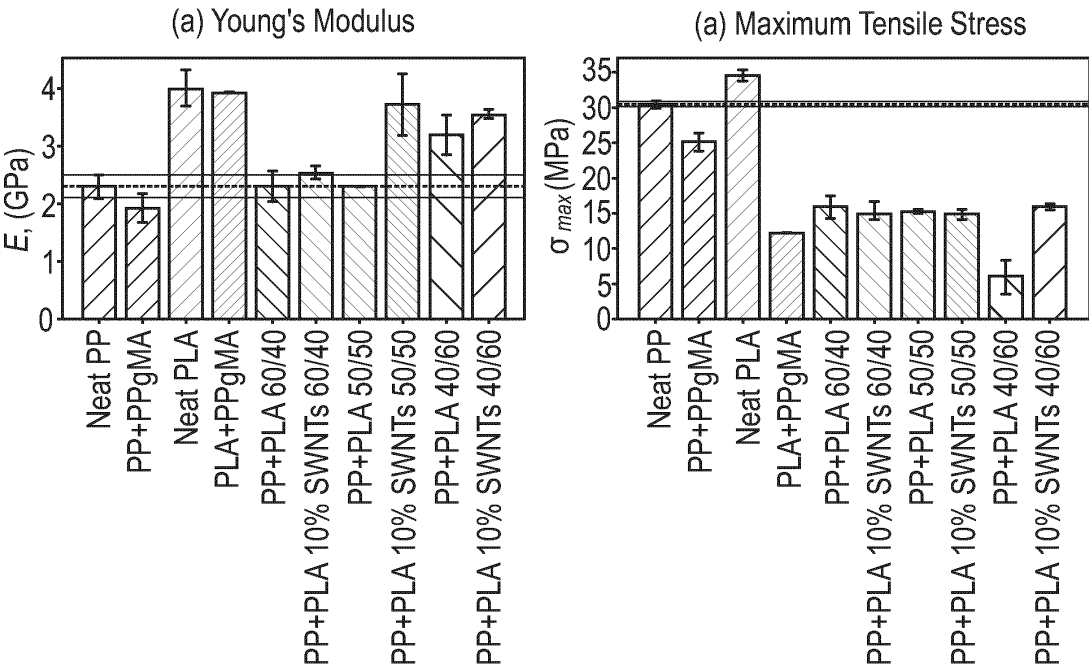


Figure 38 : Different blends of PLA, PP and PPgMA with and without carbon nanotubes

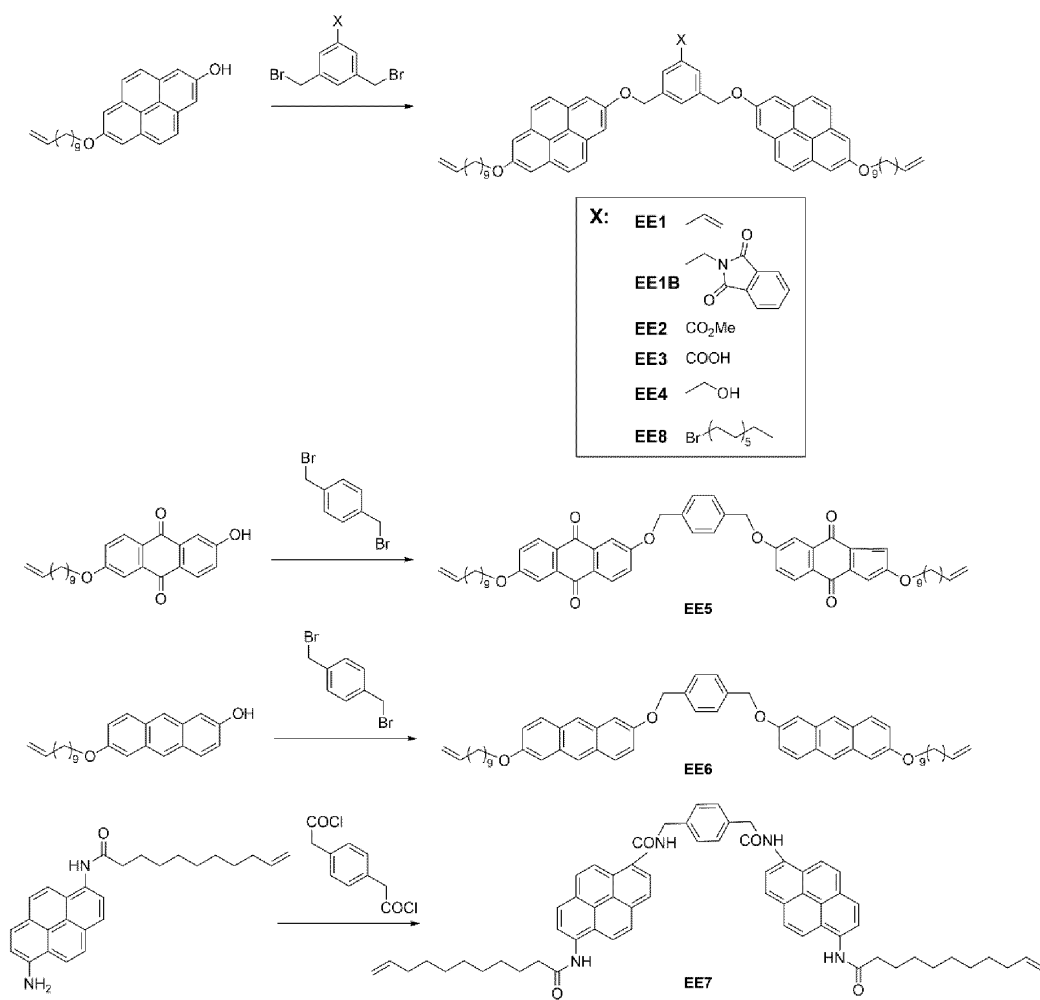


Figure 39.

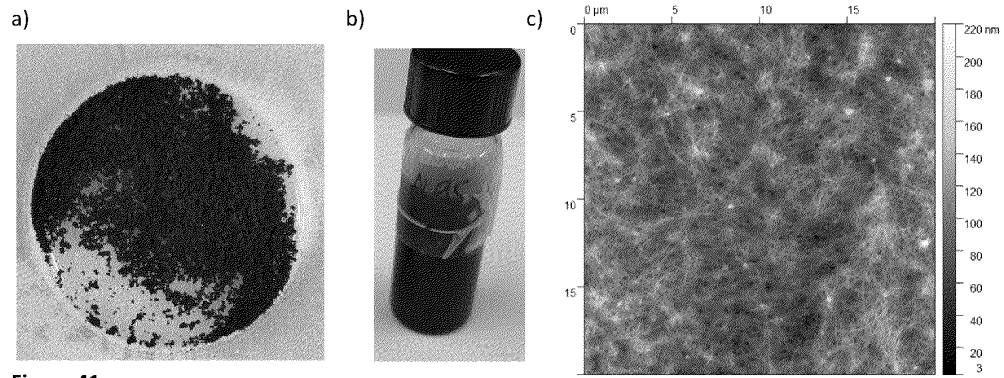


Figure 41.

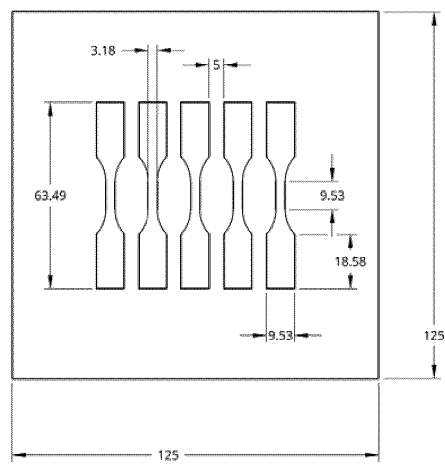


Figure 42.

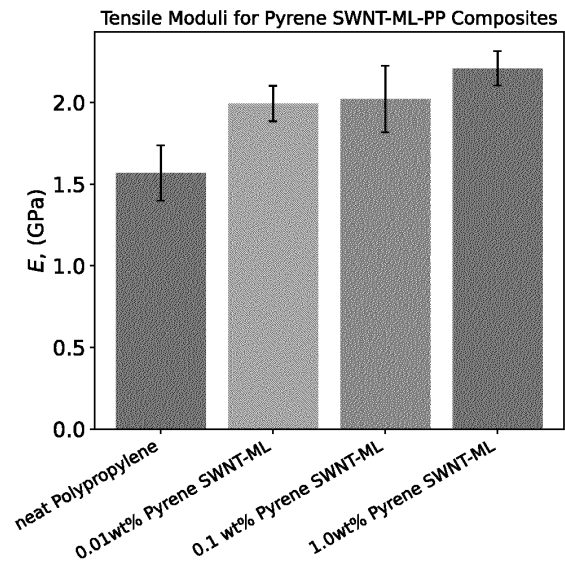


Figure 43.

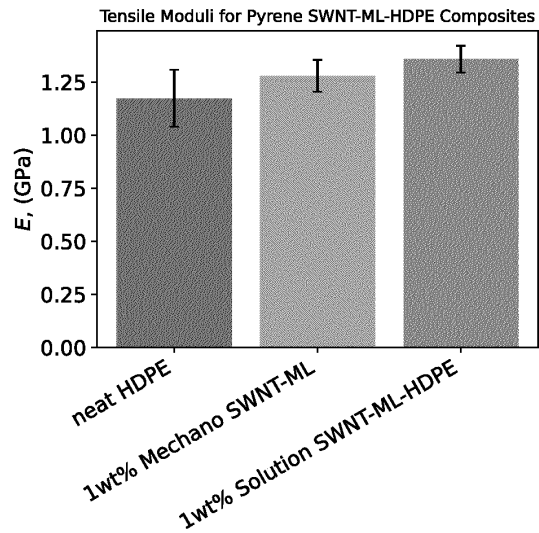


Figure 44.

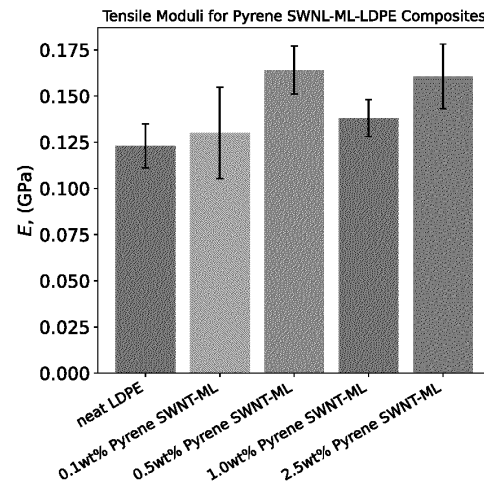


Figure 45.

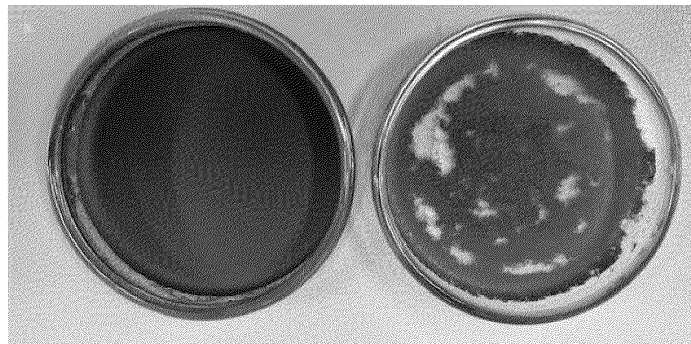


Figure 46.

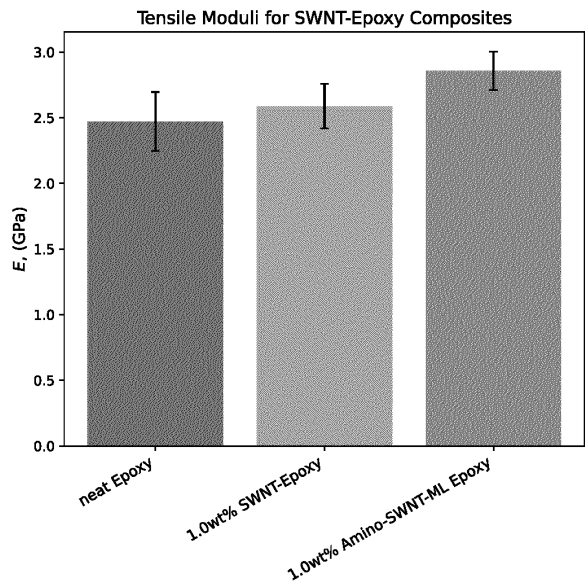


Figure 47.

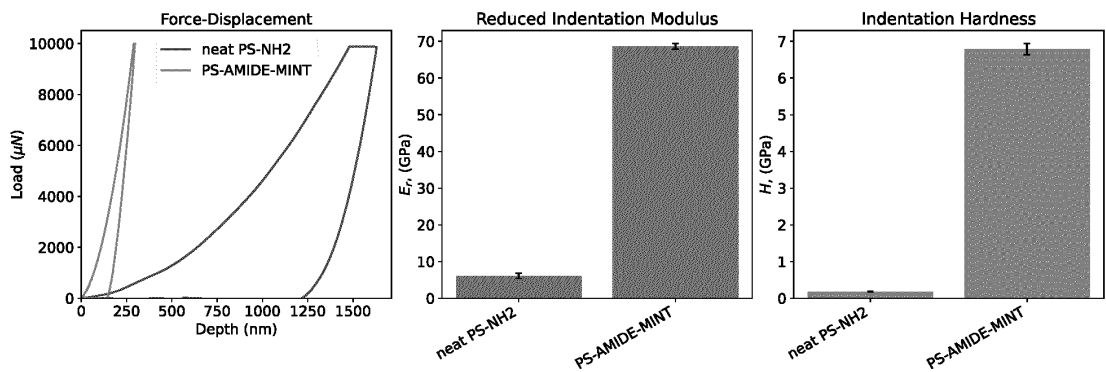


Figure 48.

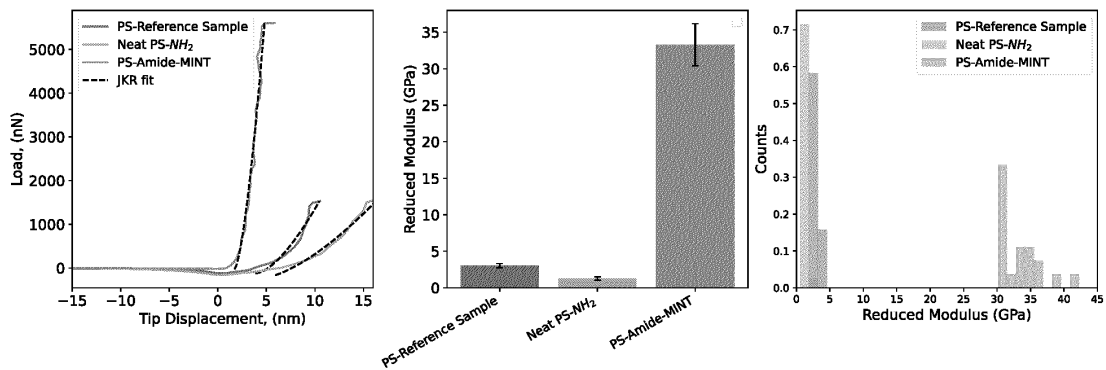


Figure 49.

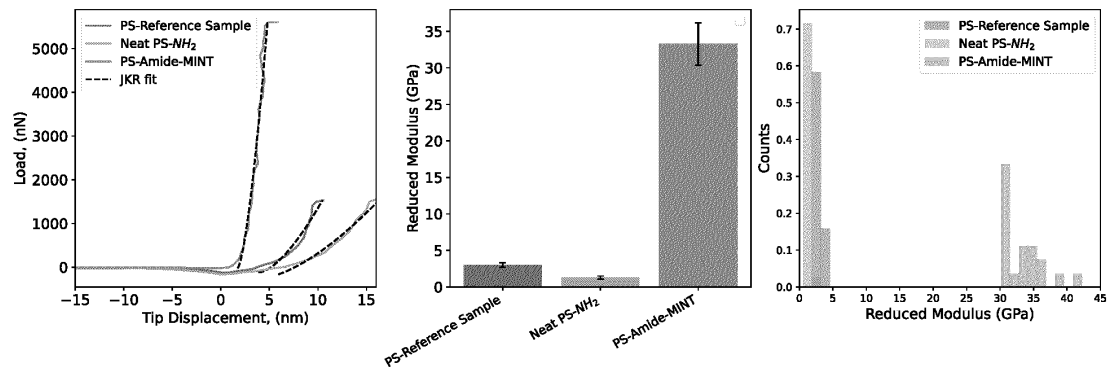


Figure 50.

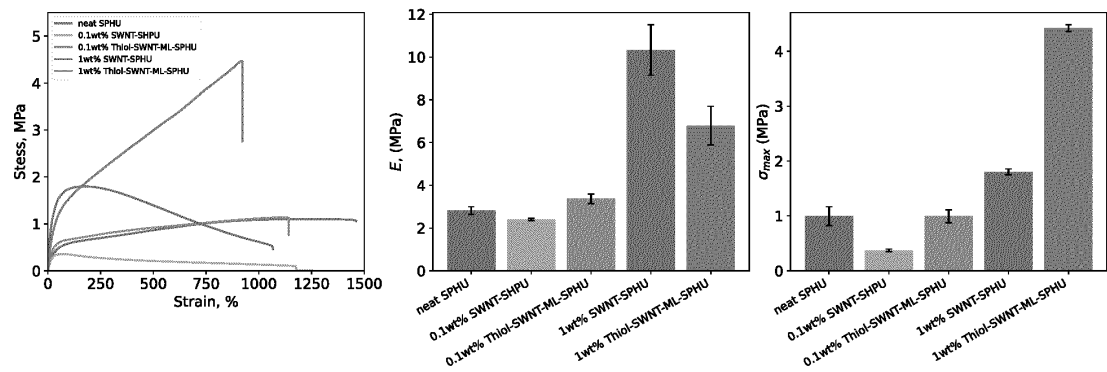


Figure 51.

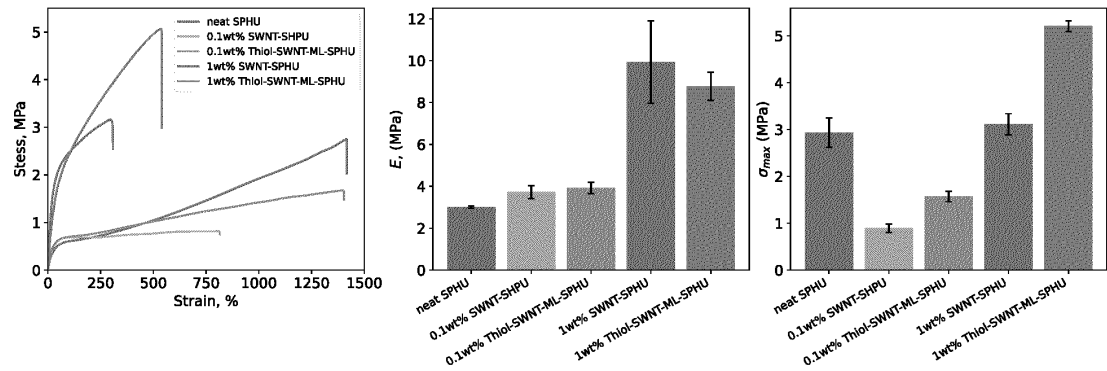


Figure 52.

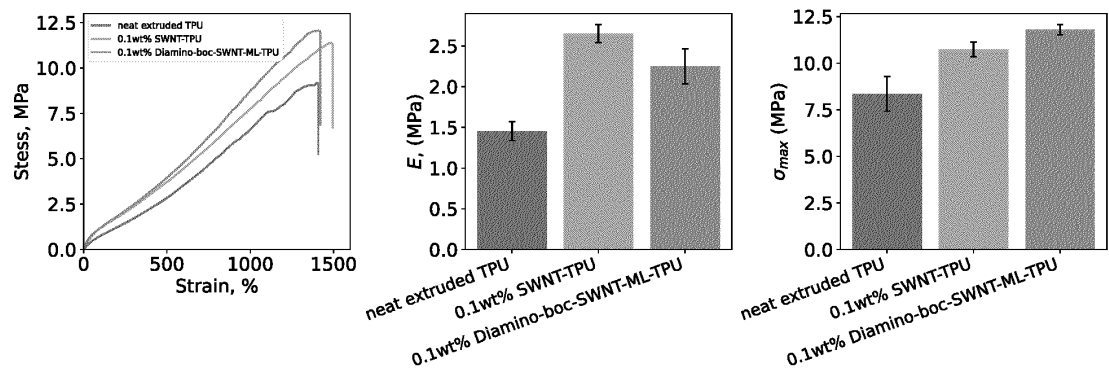


Figure 53.

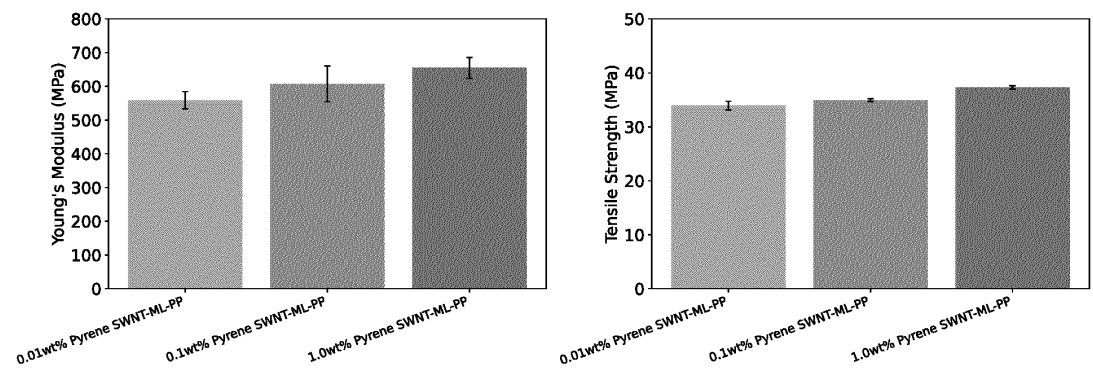


Figure 54.

Figure 55.

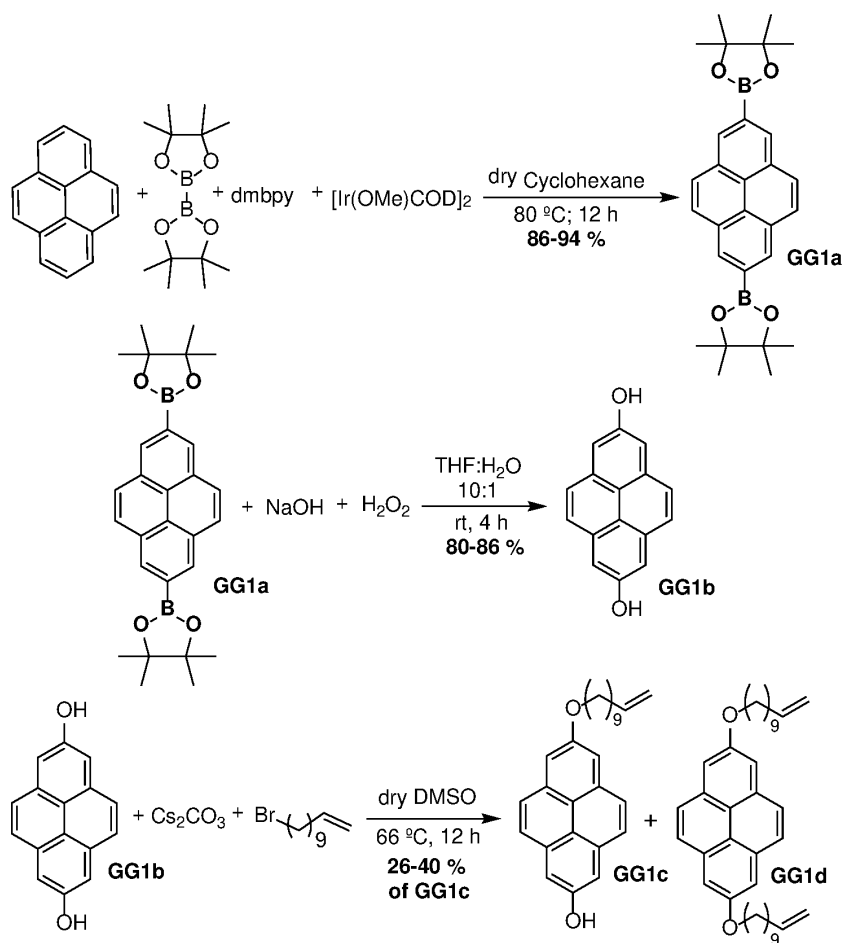


Figure 56.

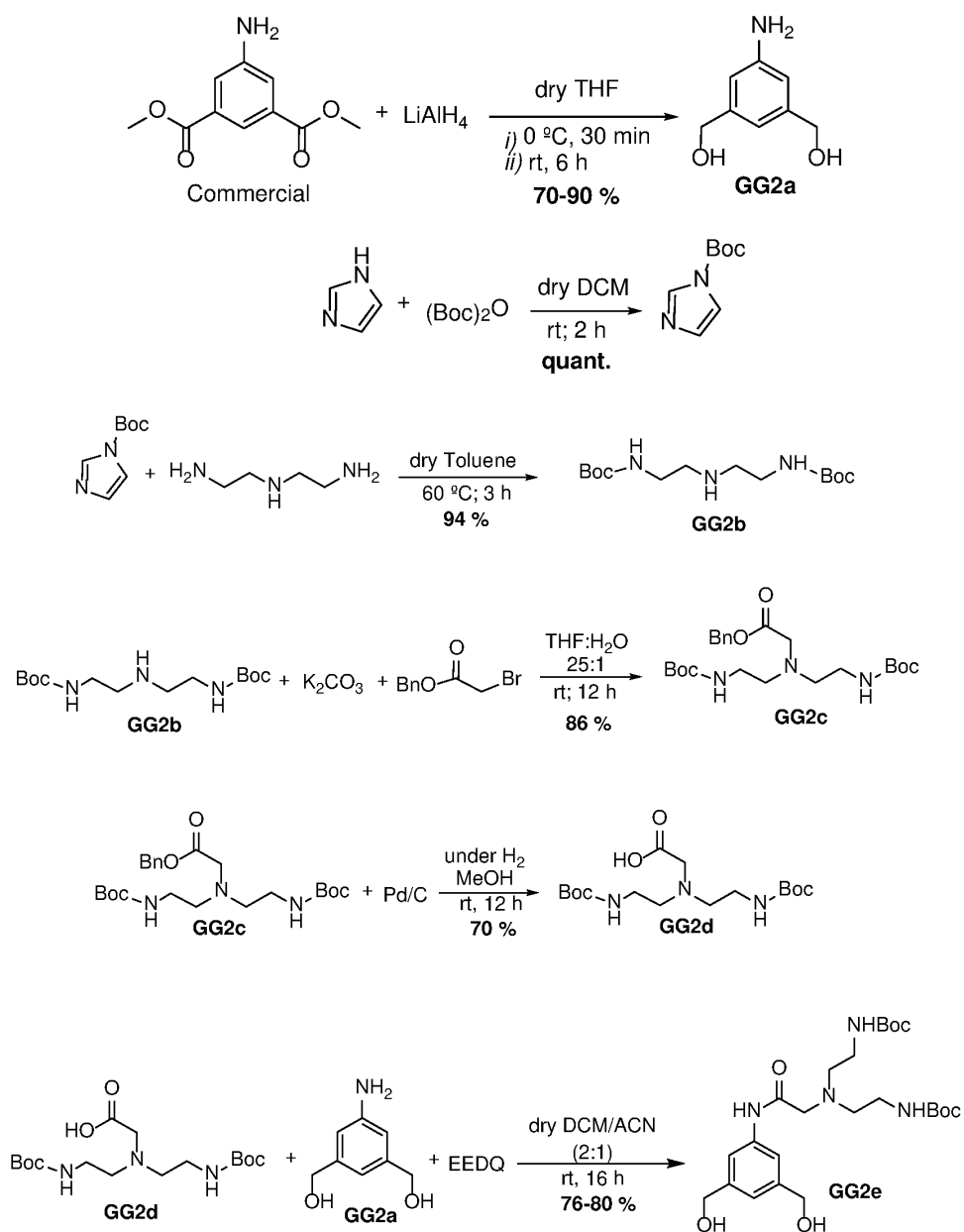


Figure 56 (contd.)

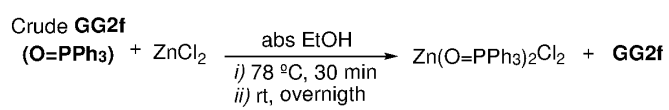
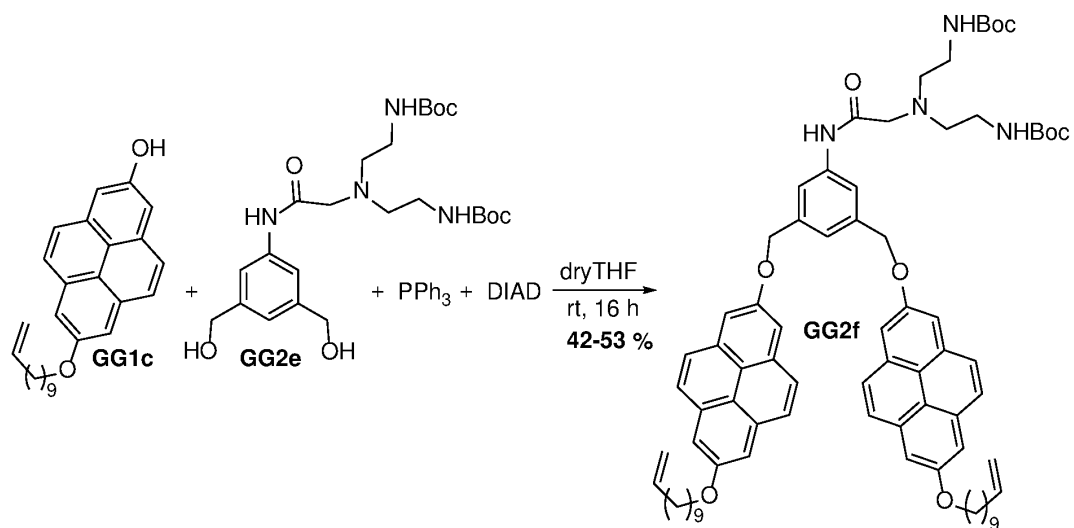


Figure 57a

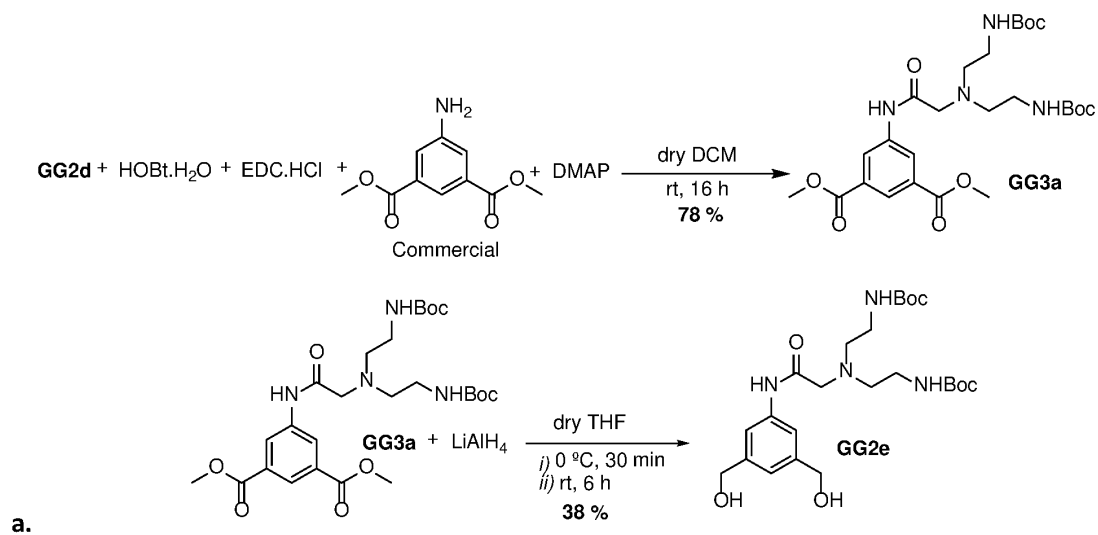


Figure 57b.

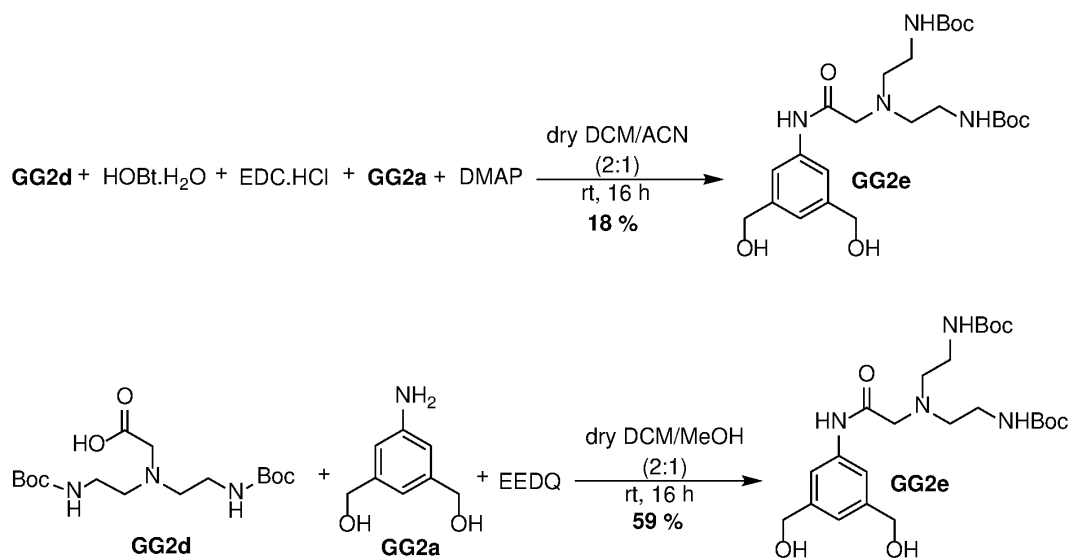


Figure 57c.

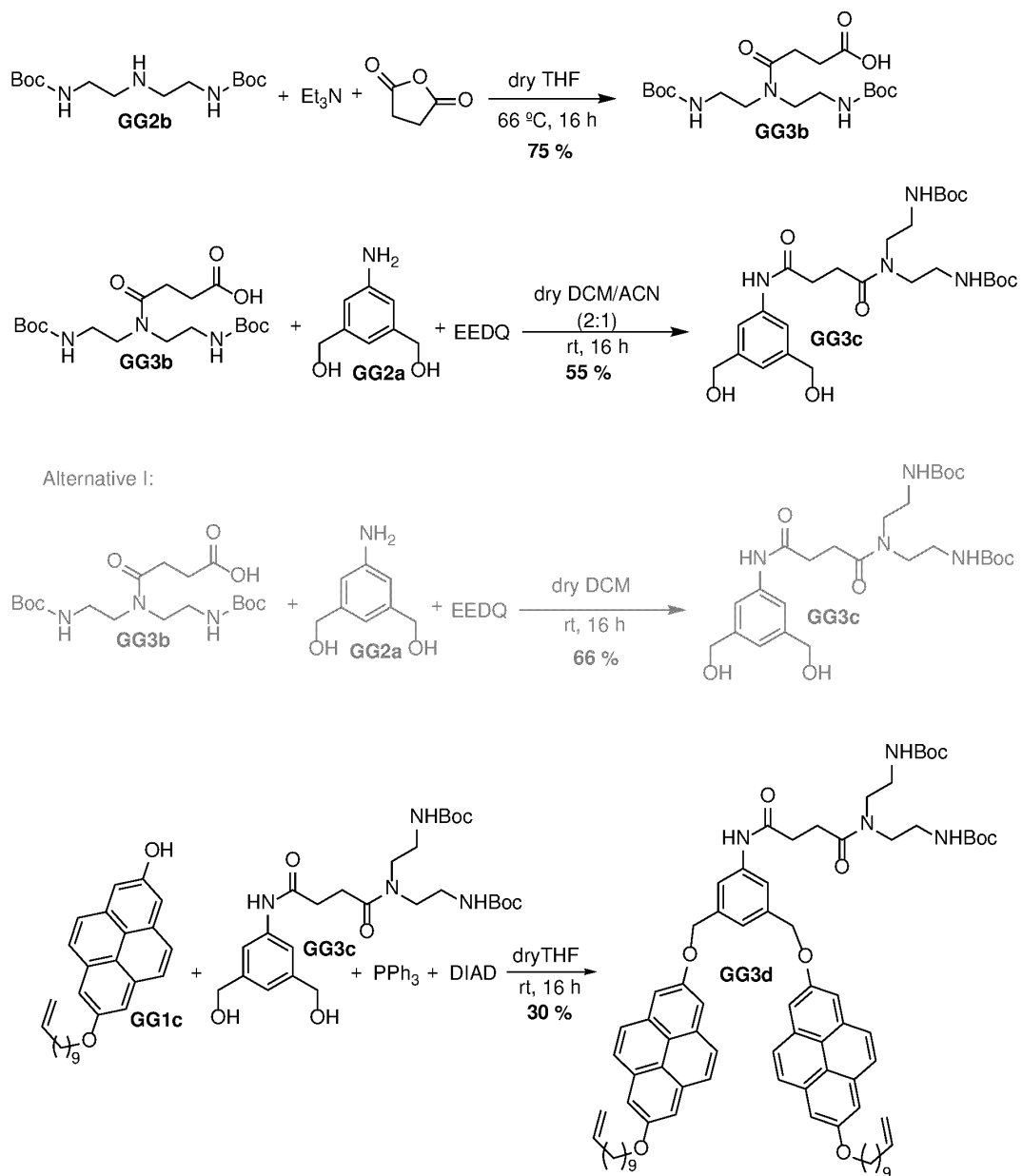


Figure 58.

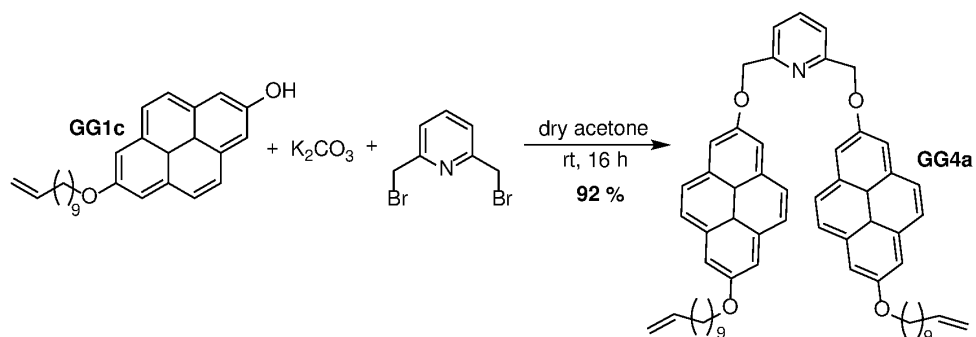


Figure 59.

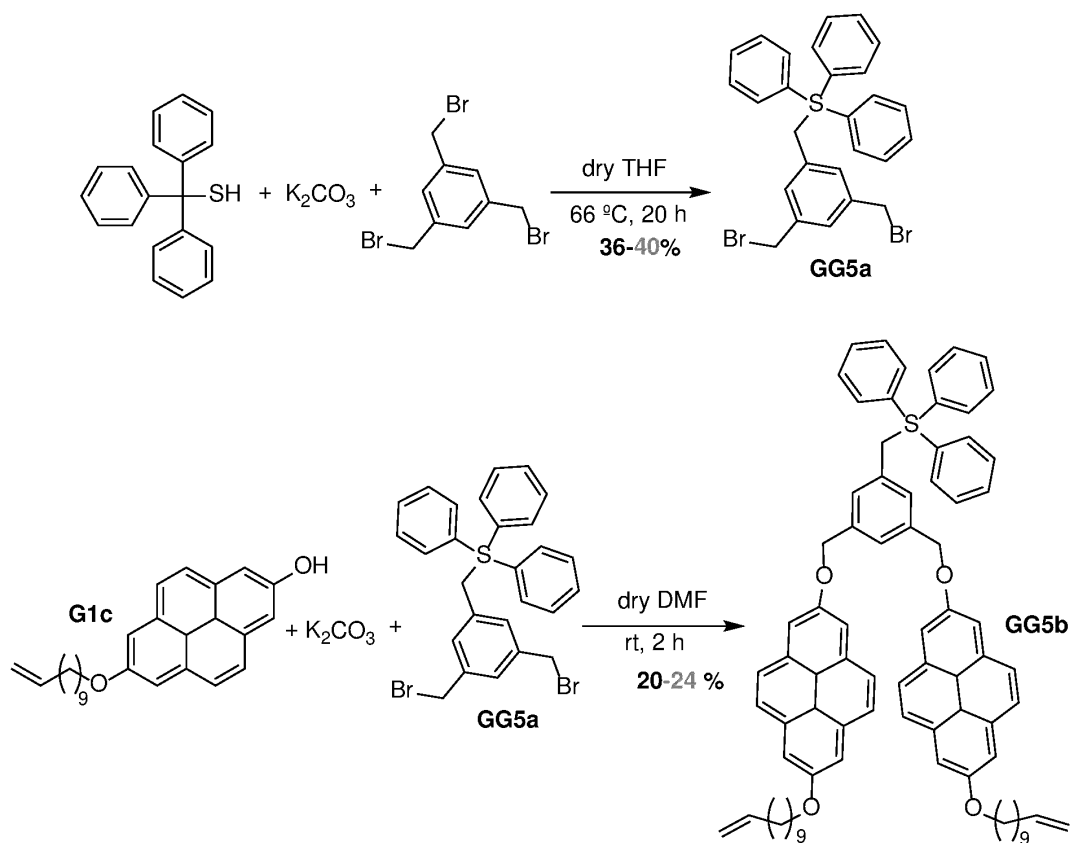


Fig. 59 (contd.)

Alternative I:

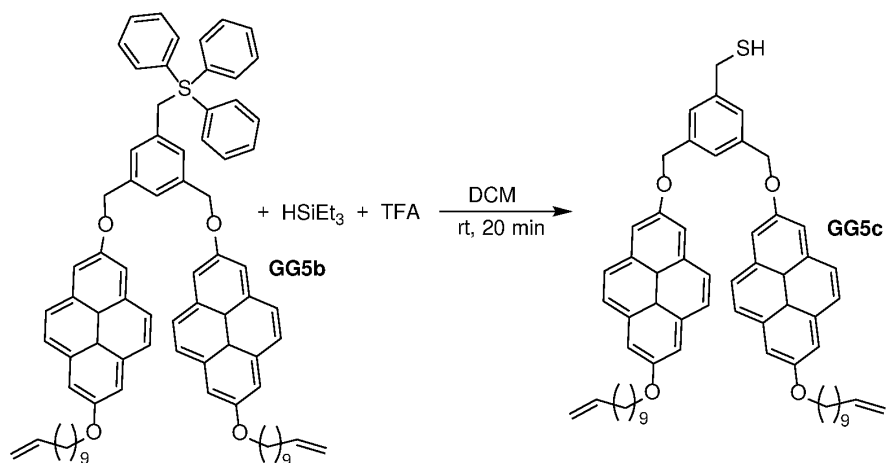
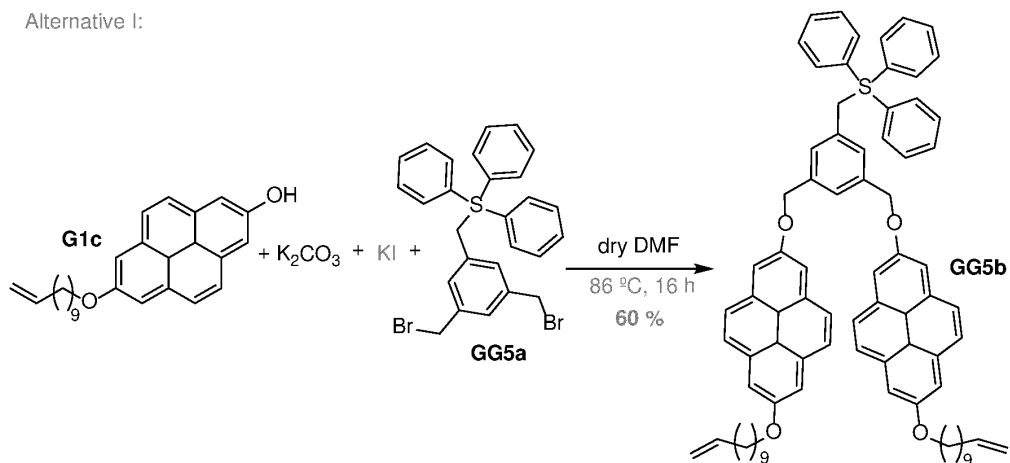


Figure 60a.

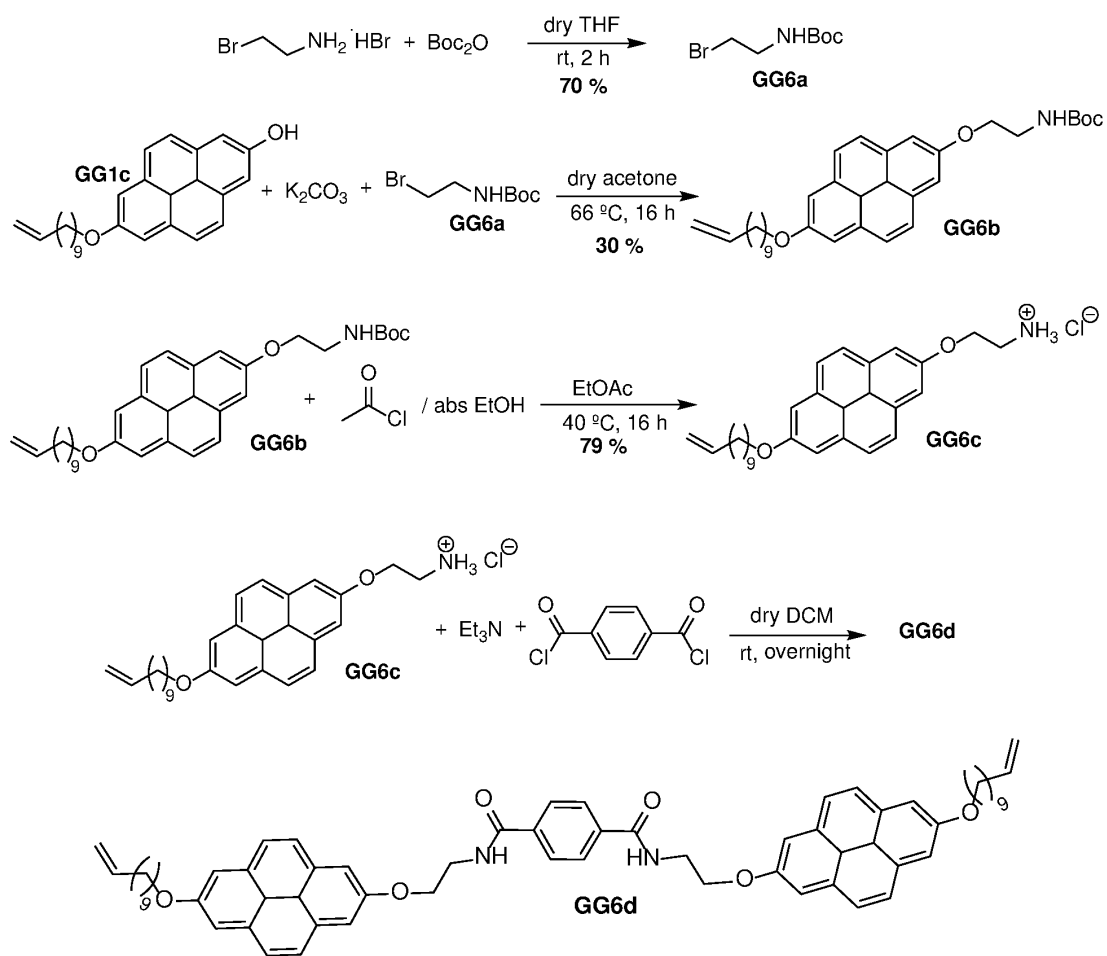


Fig 60b.

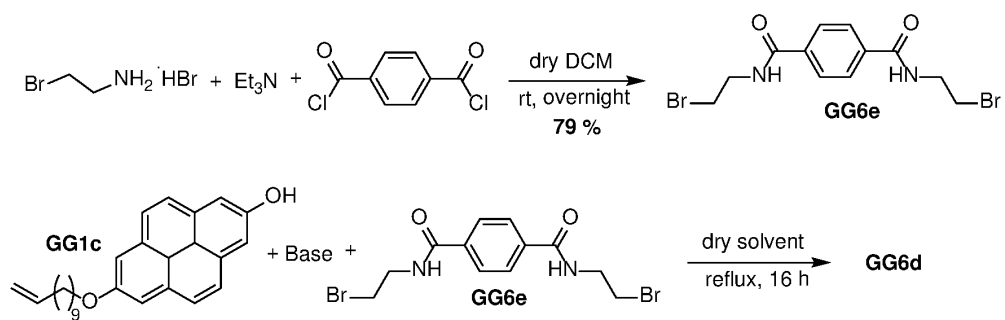
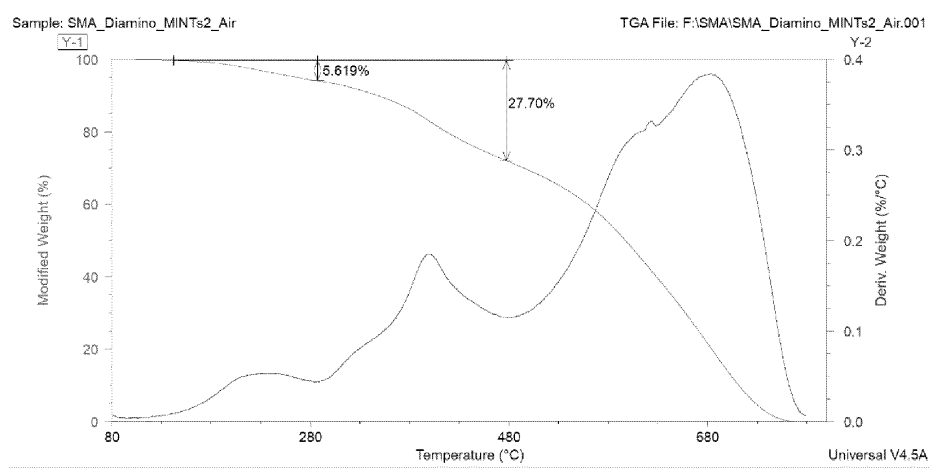


Figure 61a.

TGA



Raman

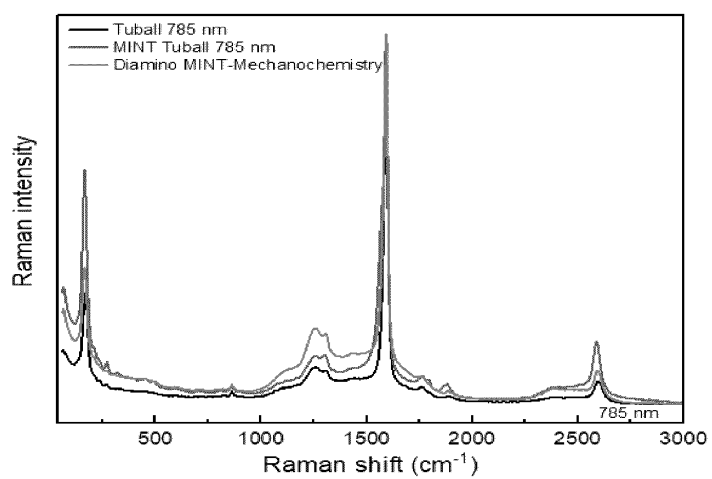


Figure 61a. (contd.)

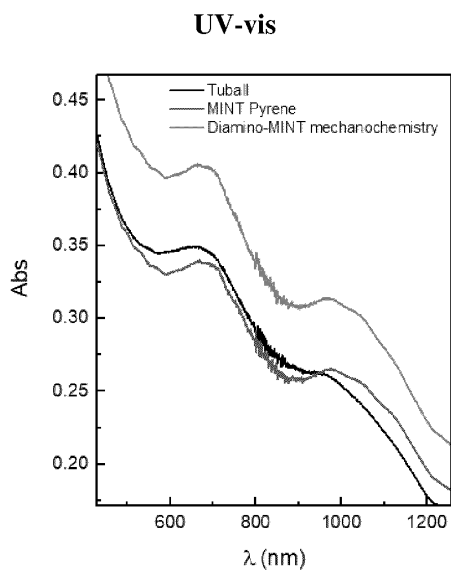


Figure 61b.

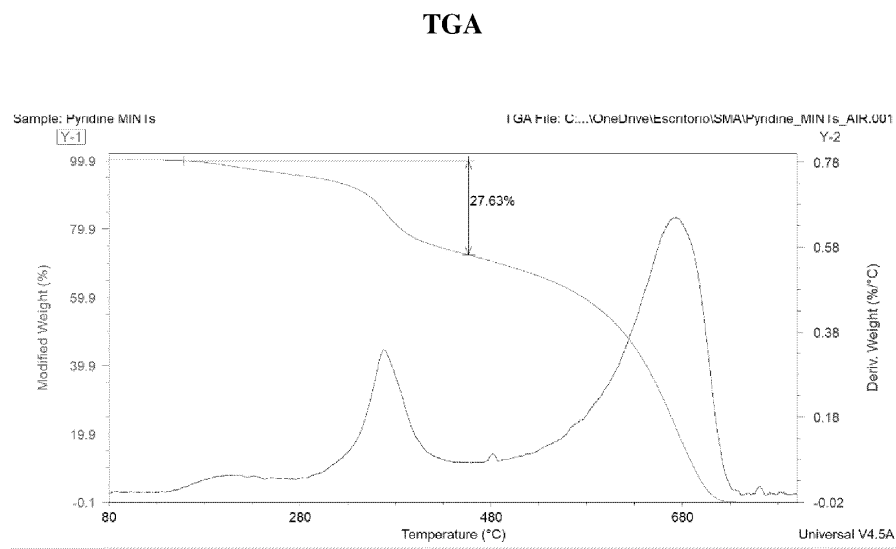


Figure 61b. (contd.)

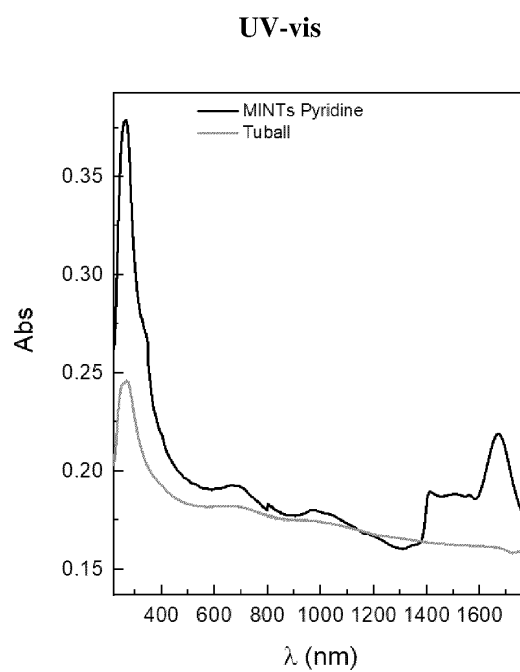
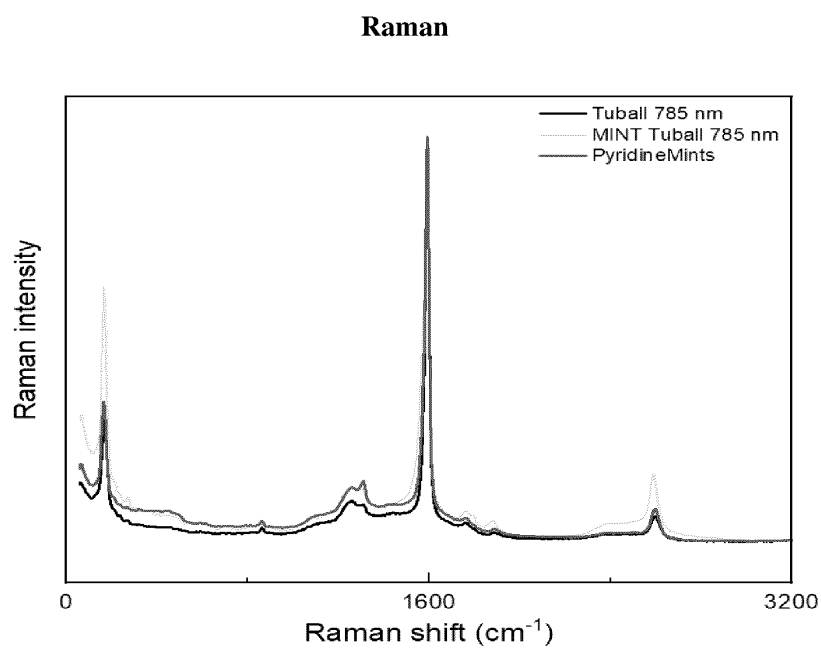


Figure 61c.

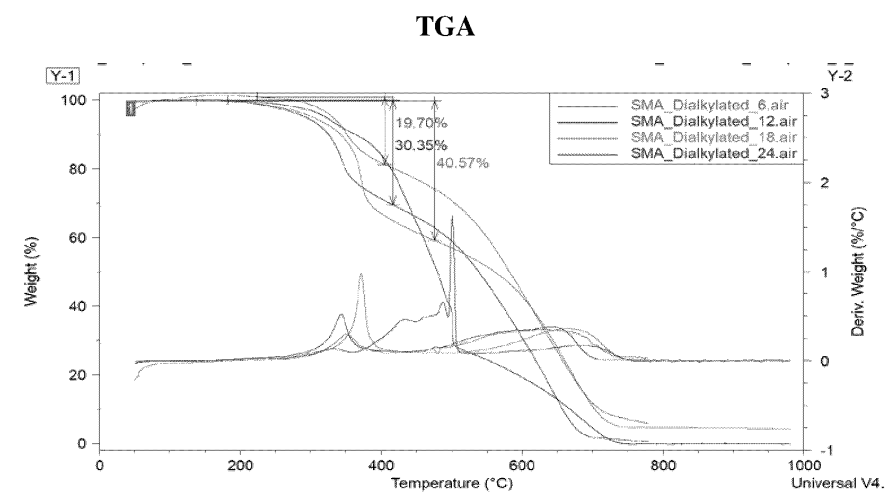


Figure 61d.

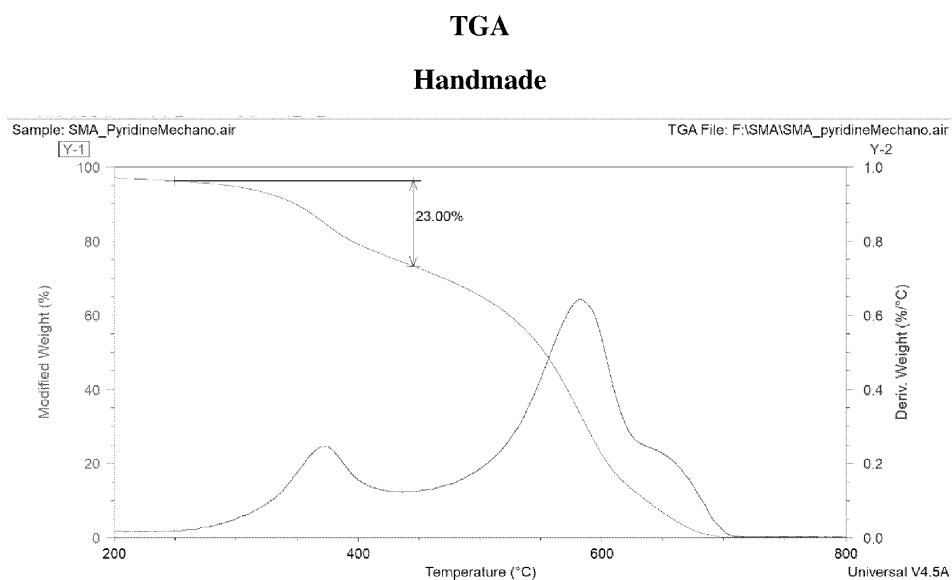


Figure 61d. (contd.)

Ball miller

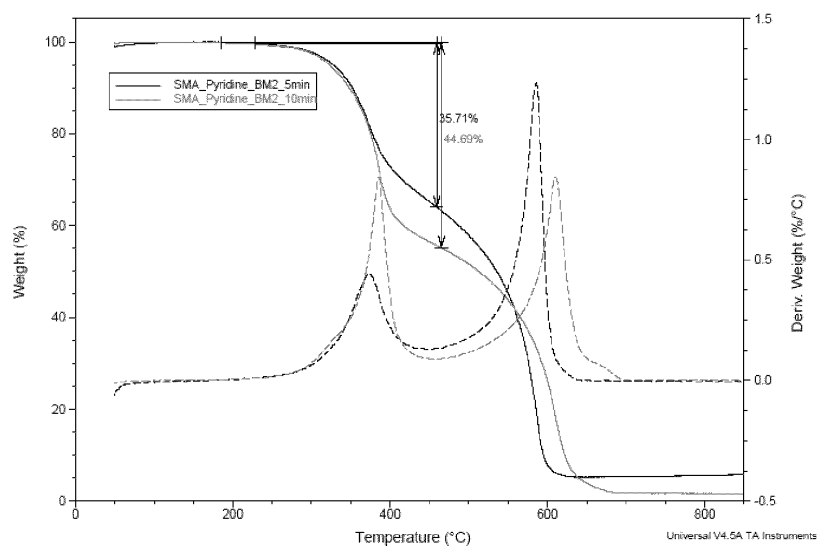
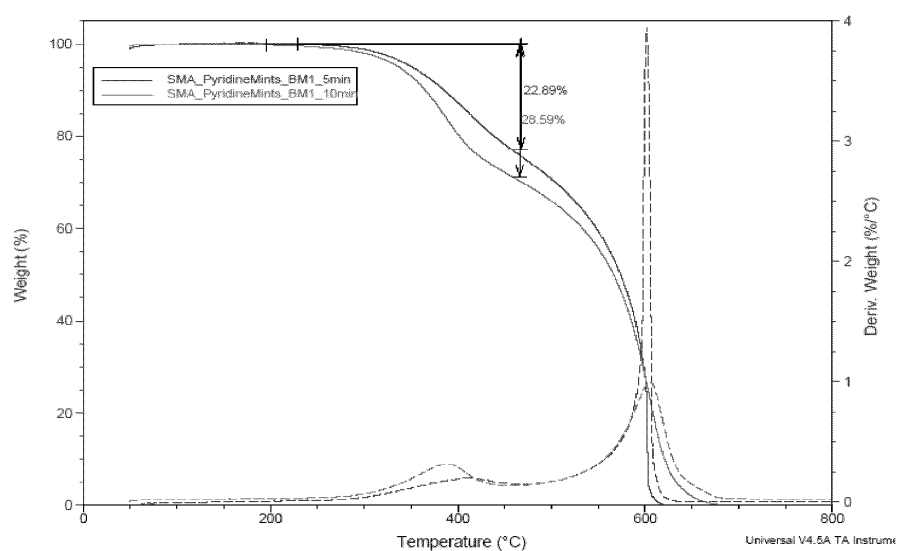
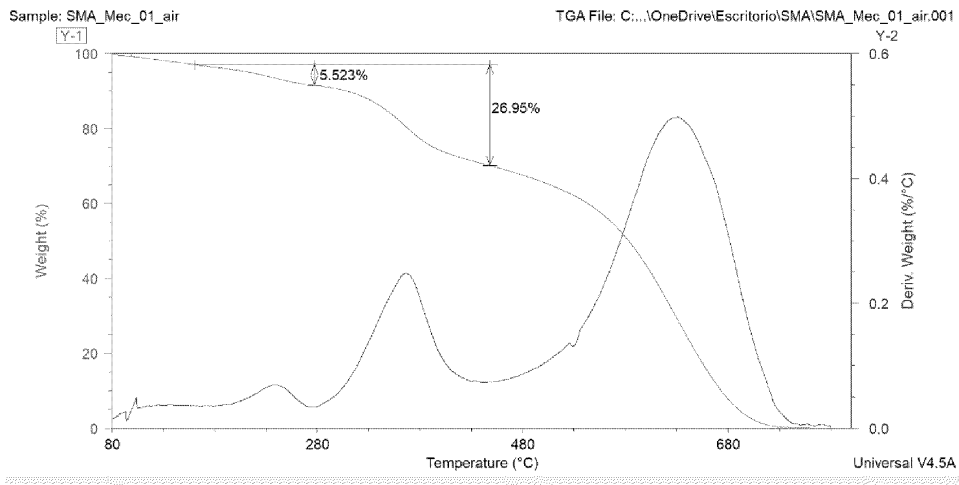


Figure 61e.

TGA
Handmade



Ball Miller

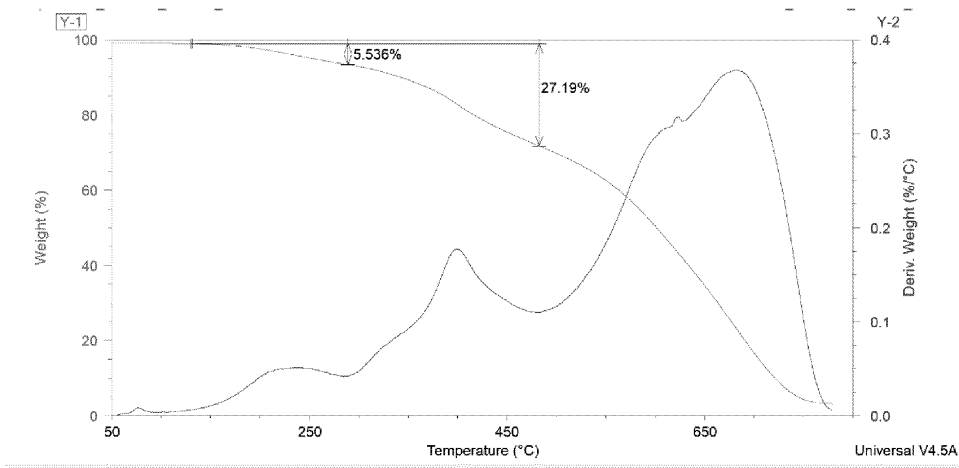
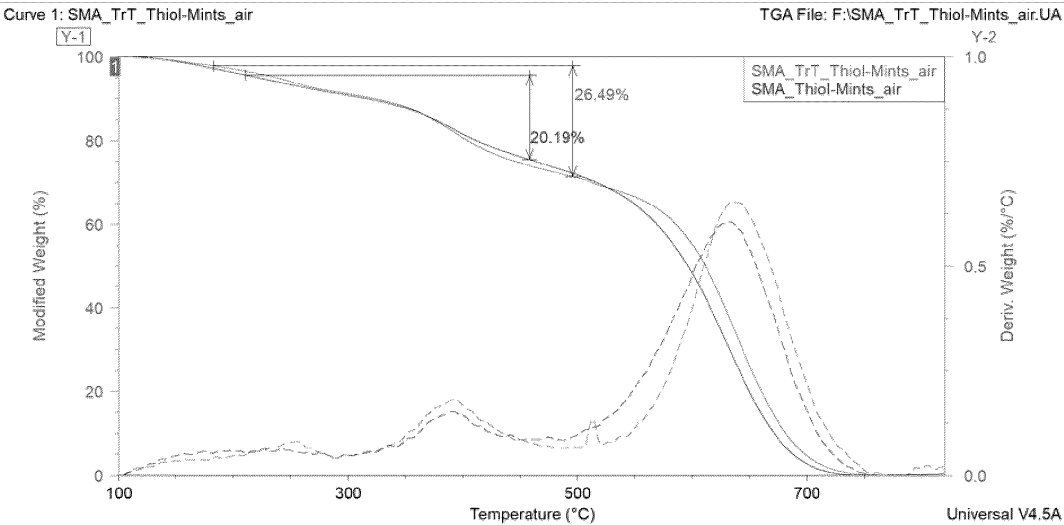


Figure 61f.

TGA
Handmade



Raman

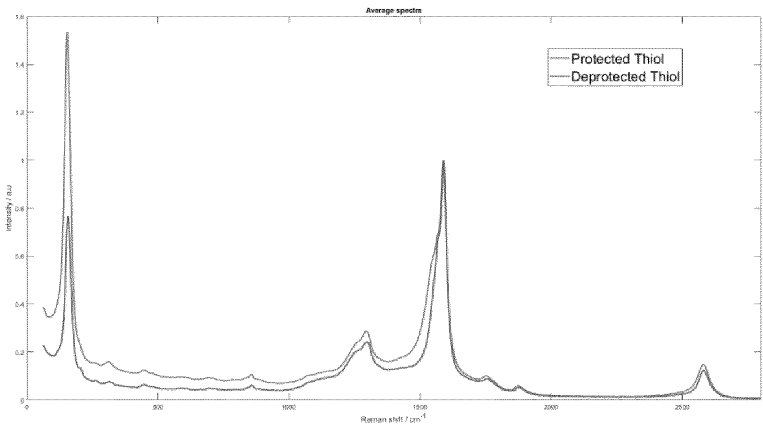
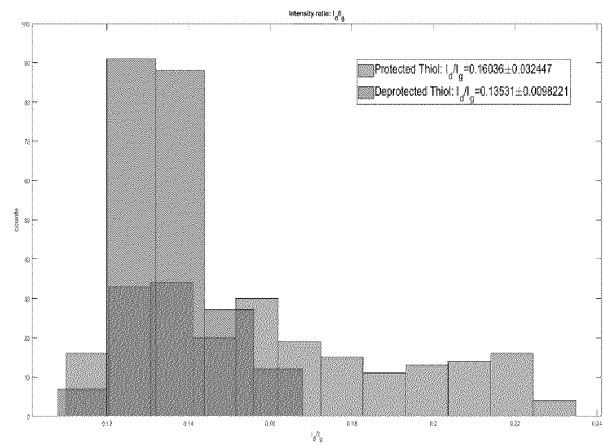


Figure 61f. (contd.)

Id/Ig



TGA

Ball miller

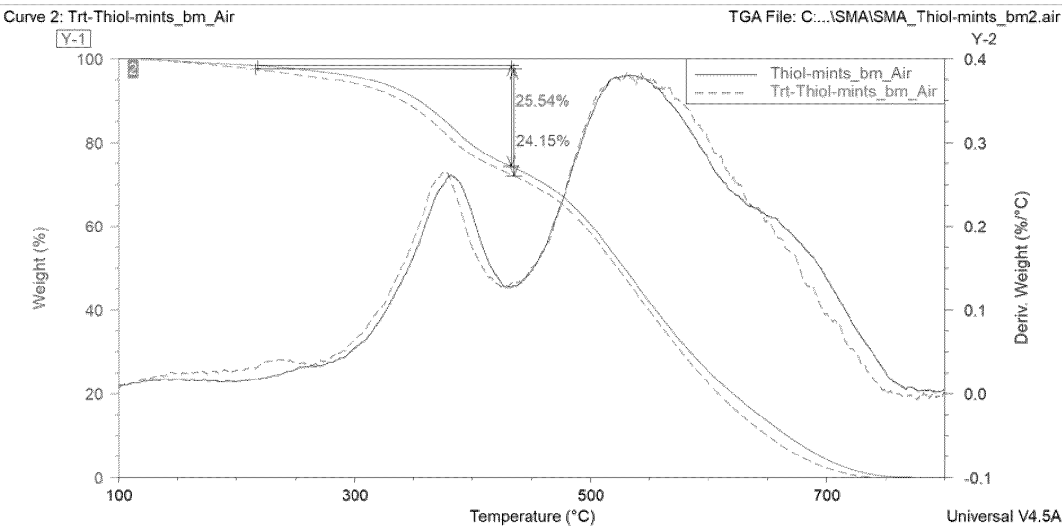


Figure 61g.

TGA
Handmade

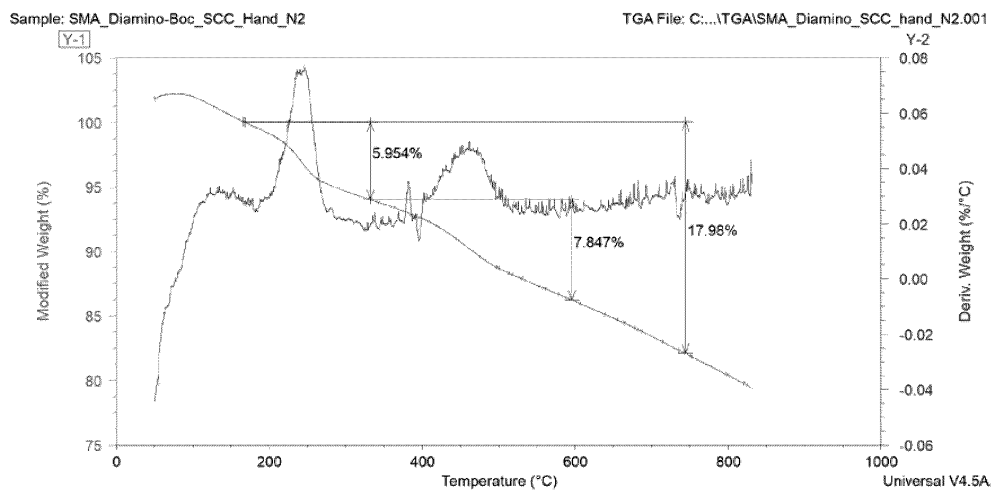
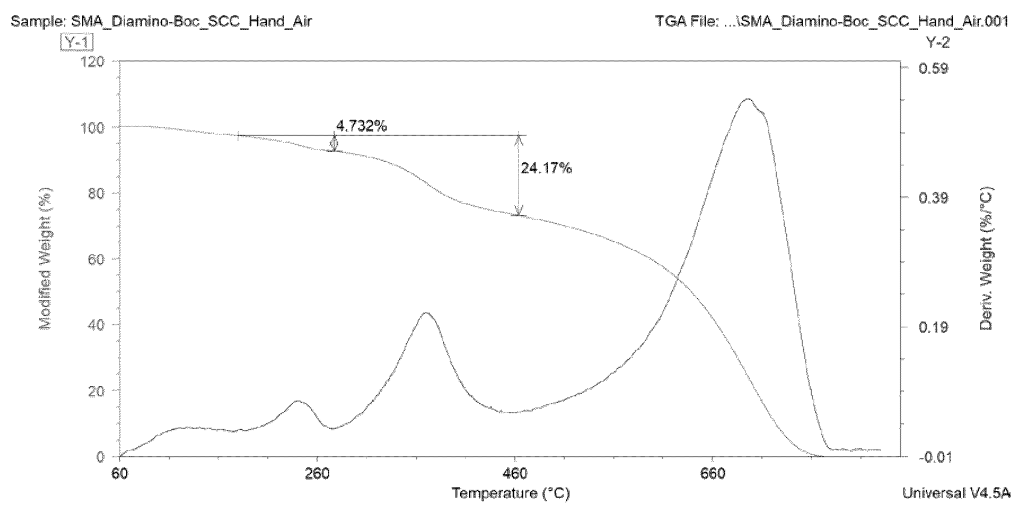


Figure 61g. (contd.)

TGA
Ball Mill

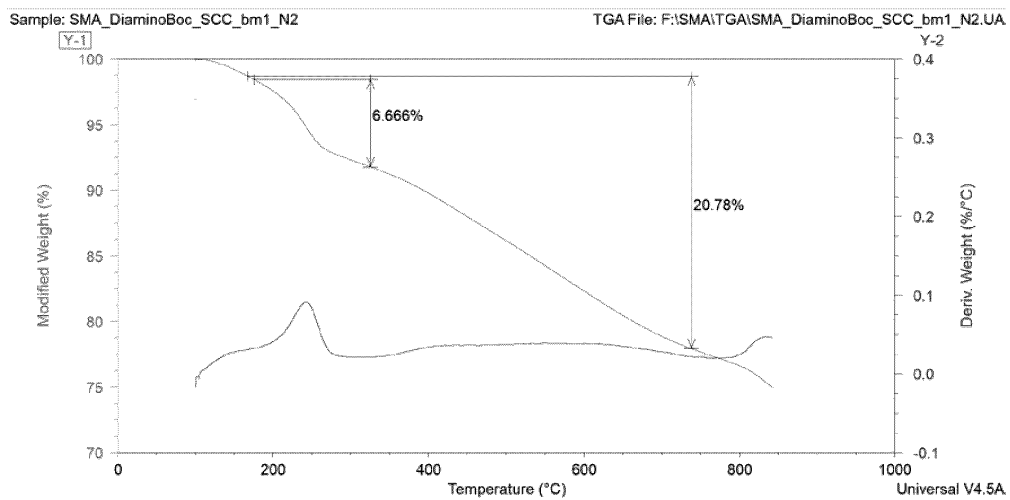
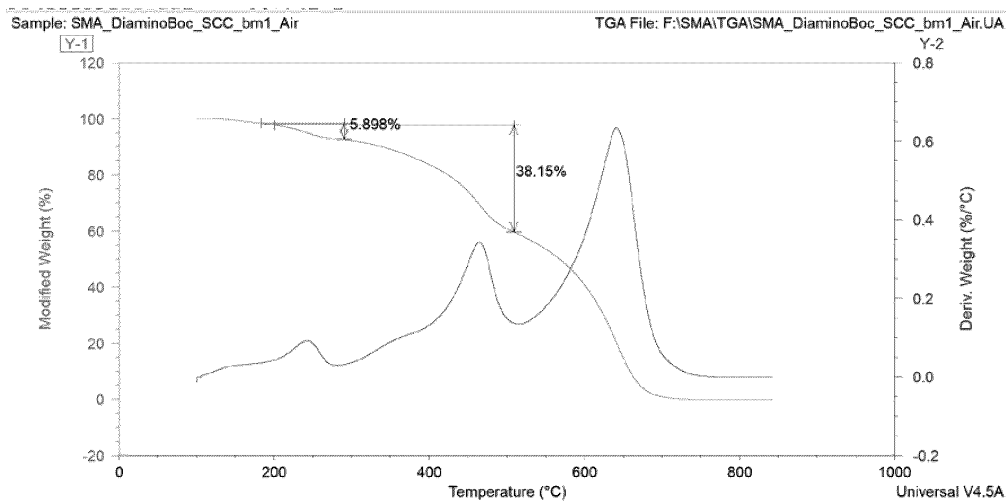
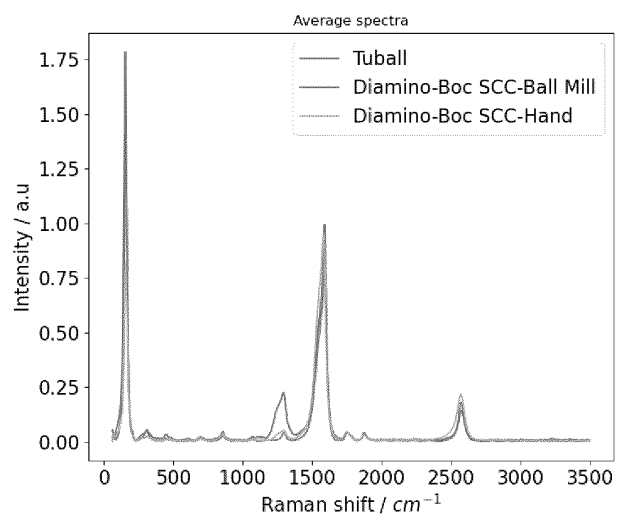
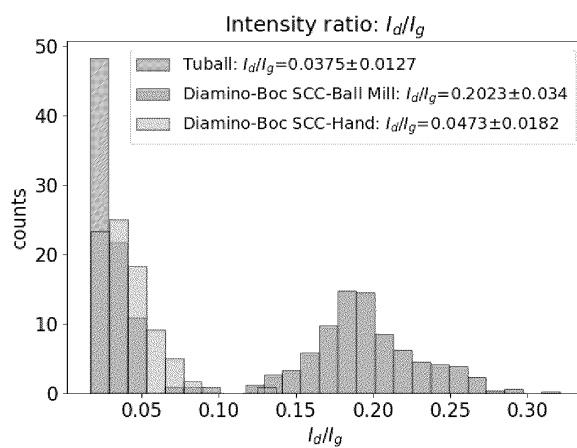


Figure 61g. (contd.)

Raman**Id/Ig**

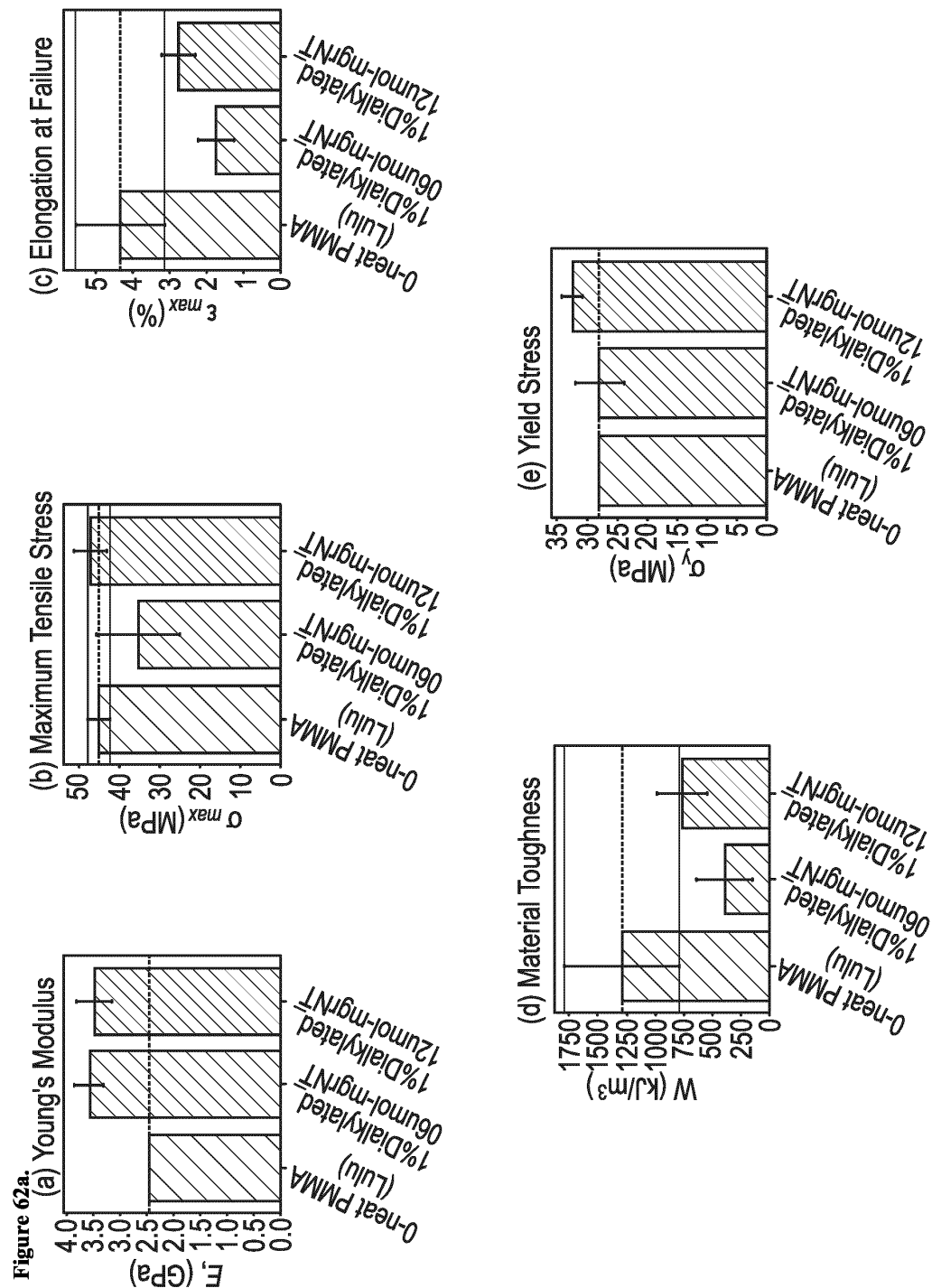


Figure 62b

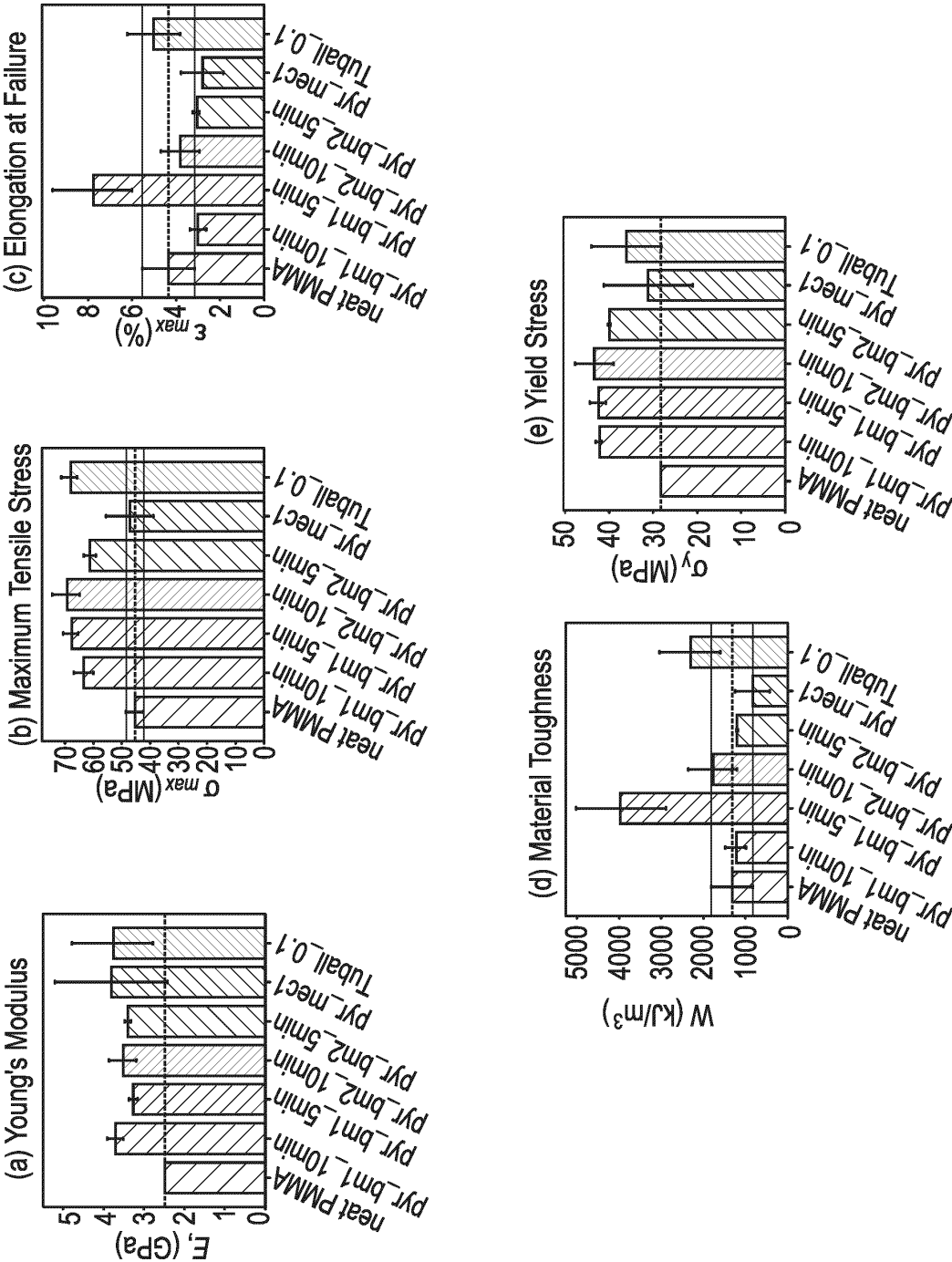


Figure 63.

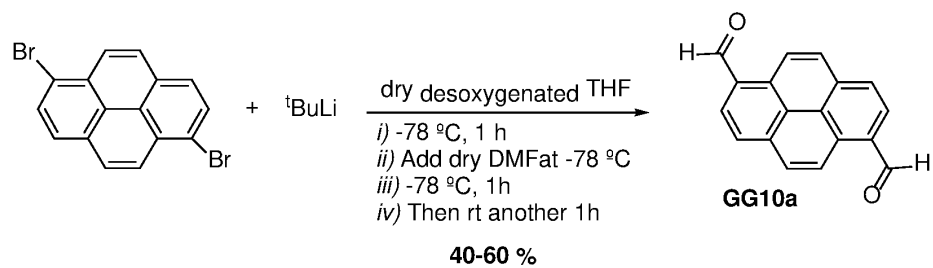


Figure 64.

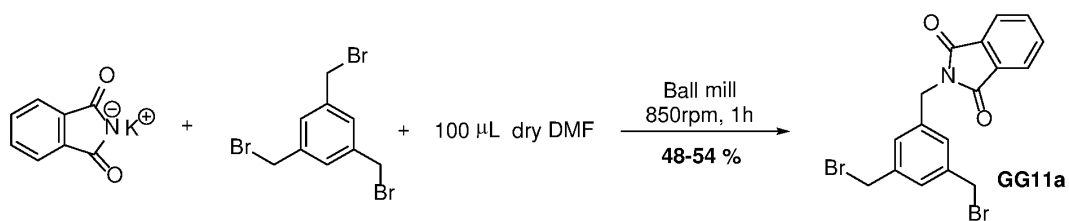


Figure 65.

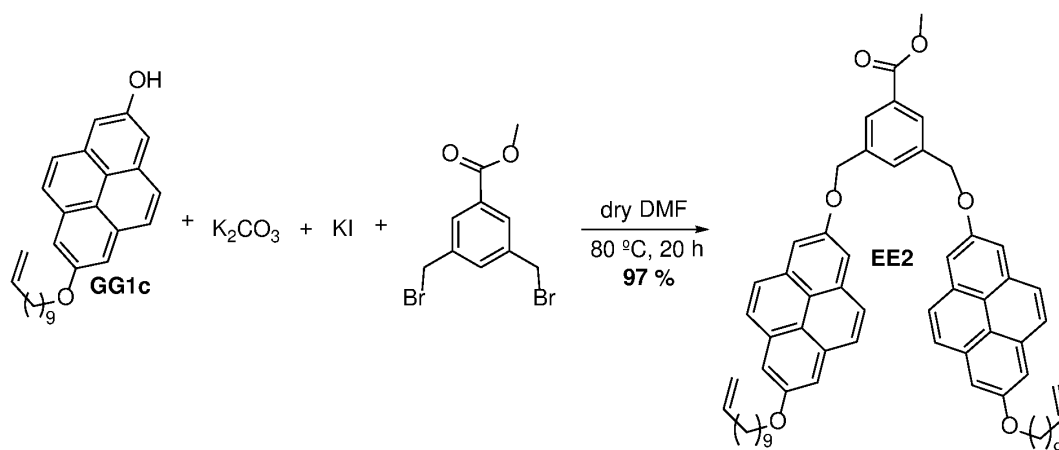


Figure 66.

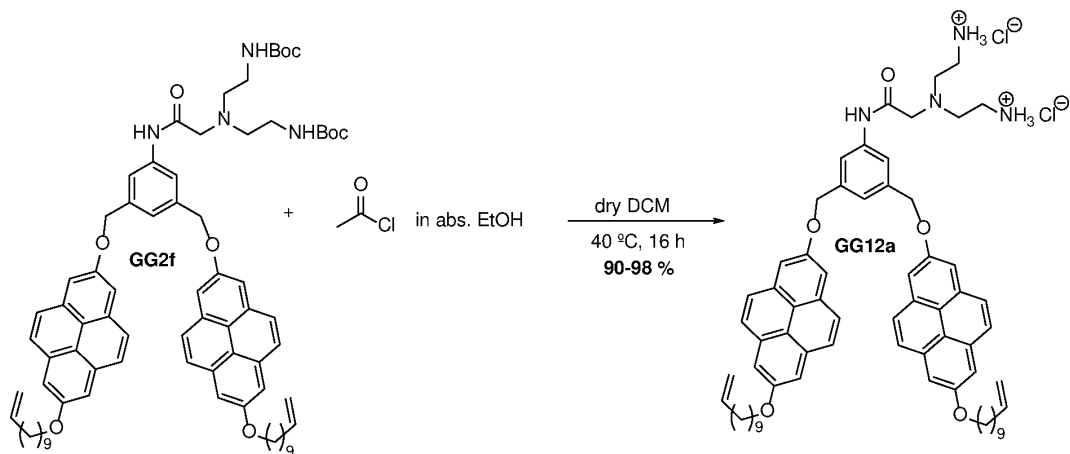
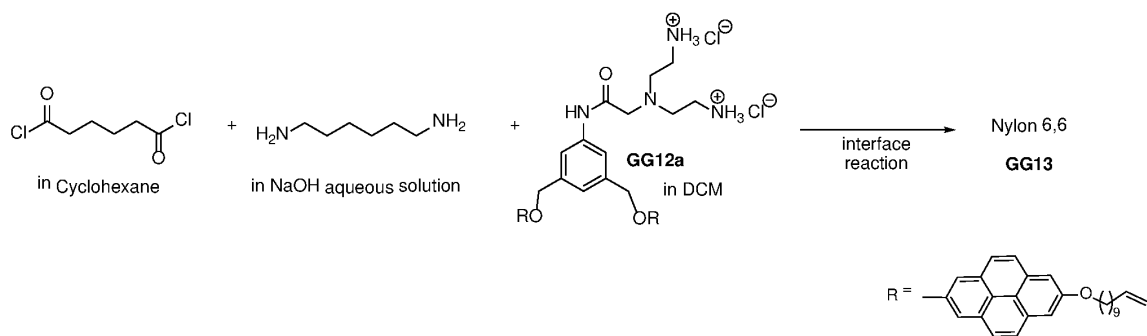


Figure 67.



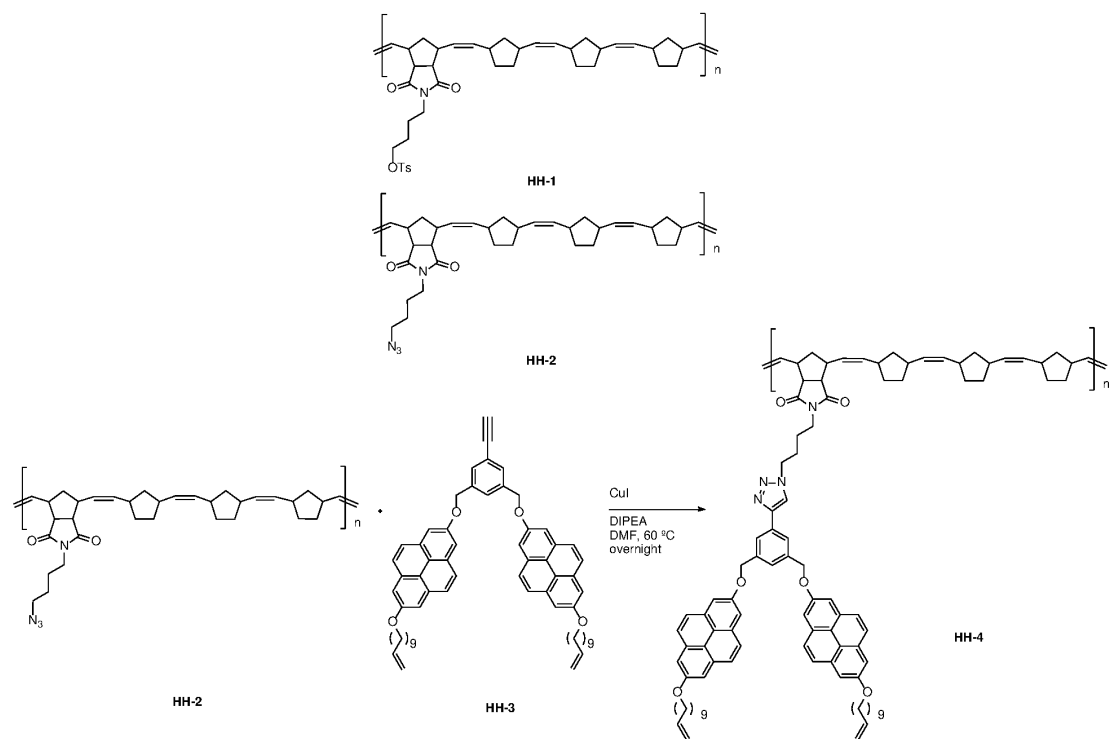


Figure 68, A.

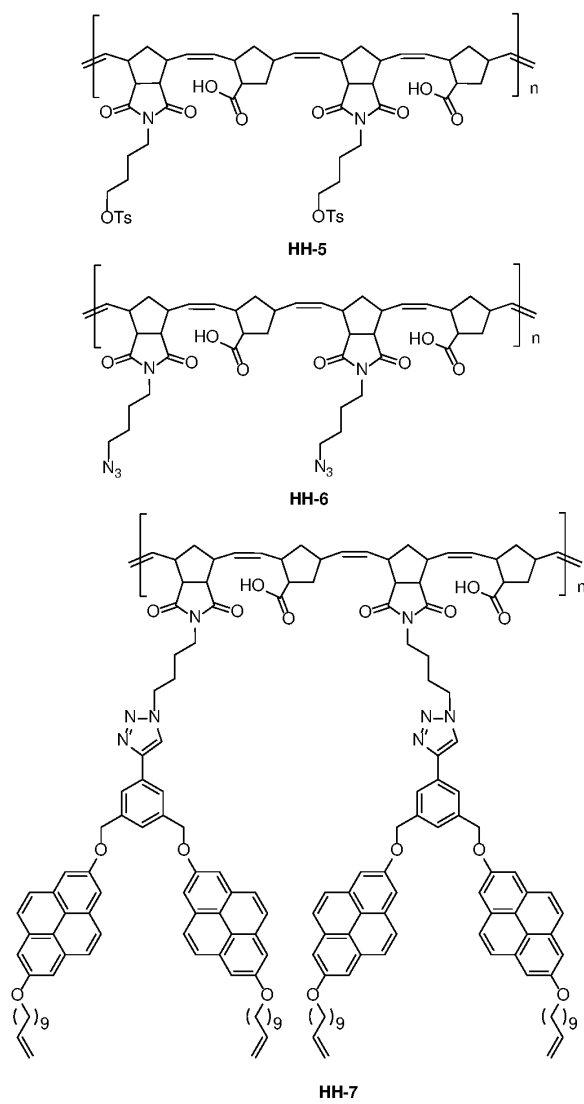


Figure 68, B.

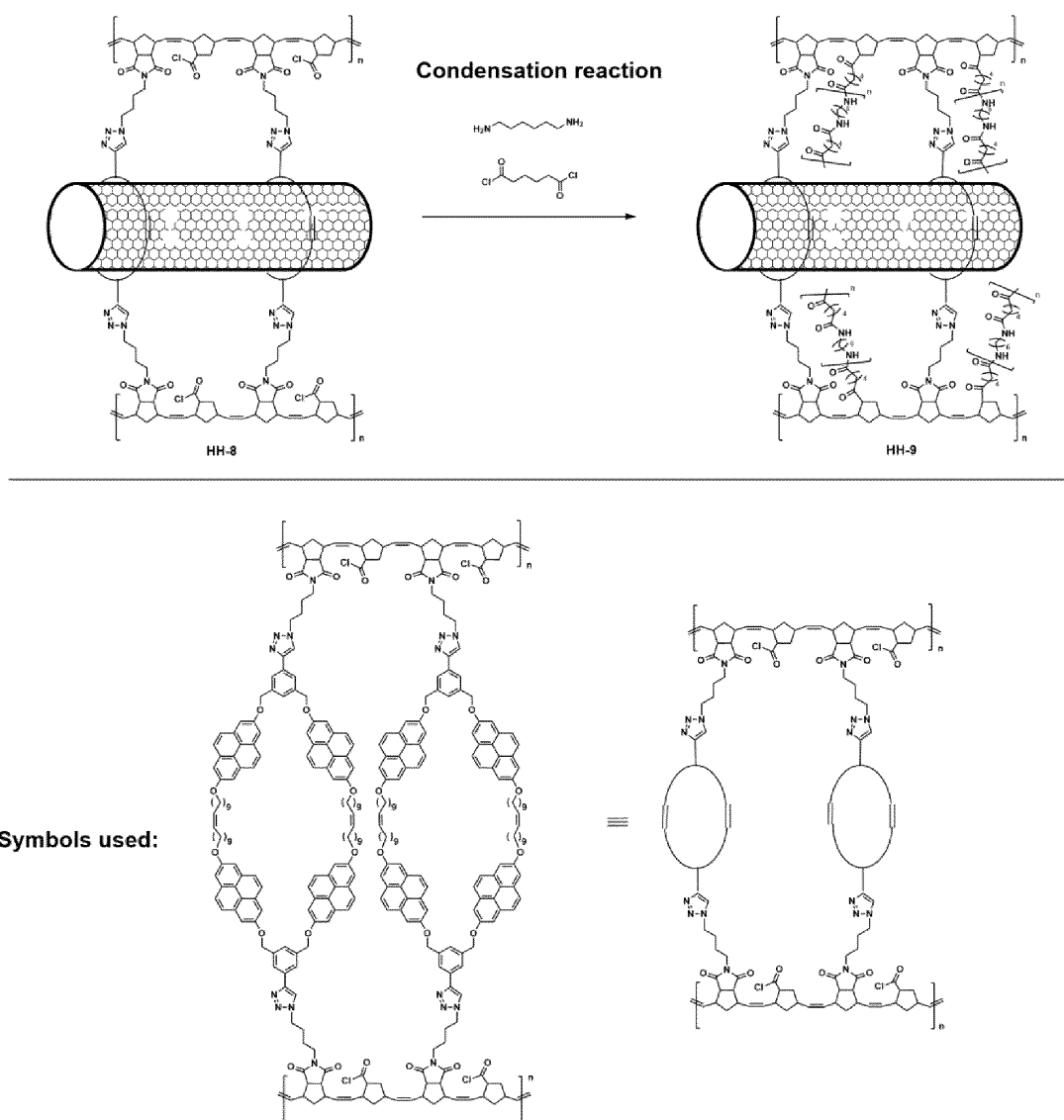
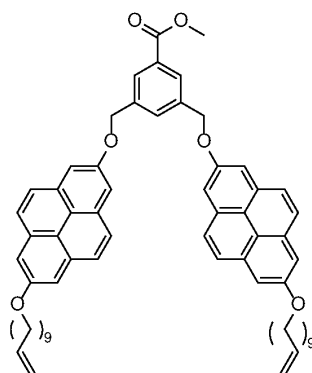
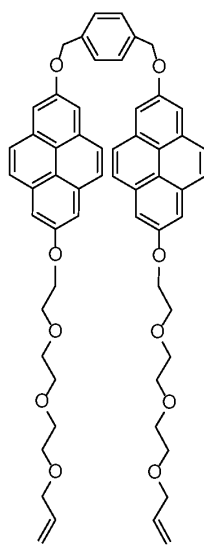


Figure 68, C.



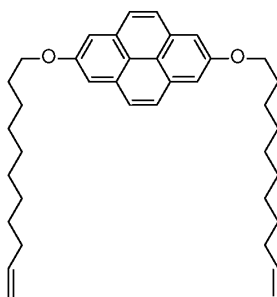
HH-10

Figure 68, D.



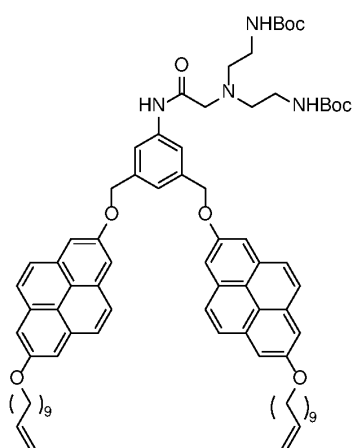
HH-11

Figure 68, E.



HH-12

Figure 68, F.



HH-13

Figure 68, G.

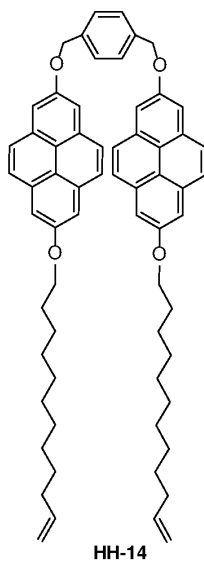


Figure 68, H.

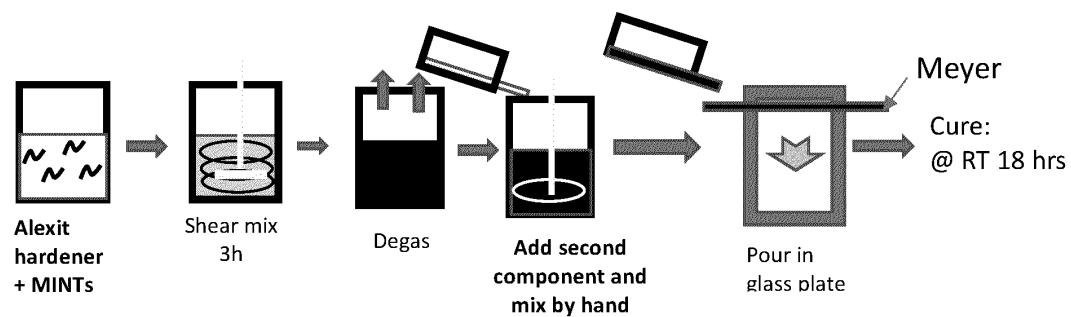


Figure 68, I.

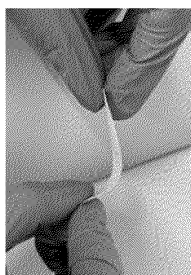


Figure 68, J.

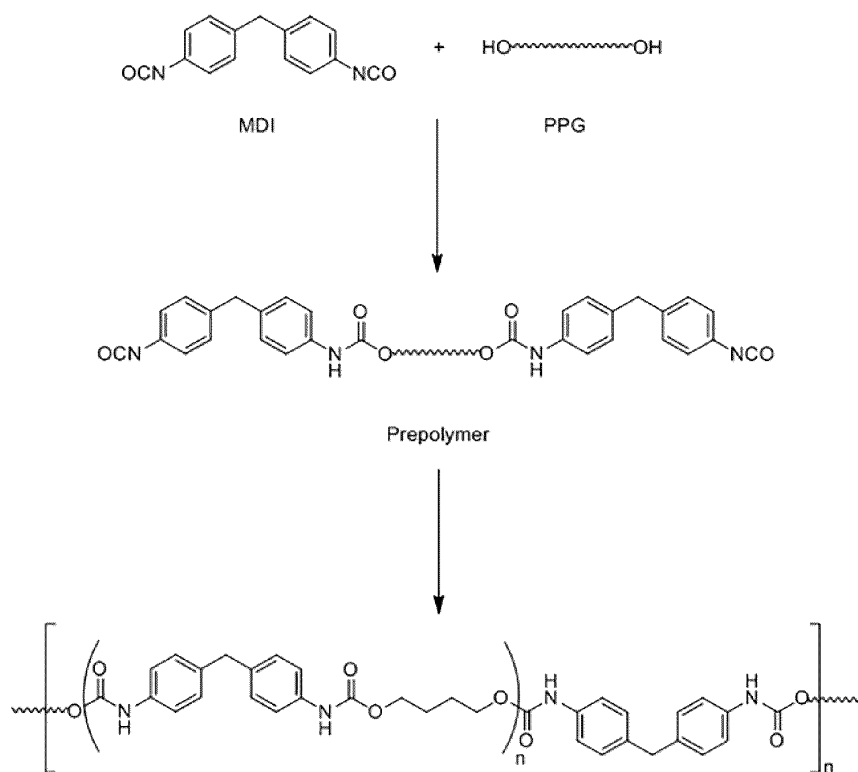


Figure 69.

In situ polyurethane general formulation			OH:NCO Ratio
	mmol	Eq.	
MDI	16	6	1 : 1.07
PPG (Mw: 2000)	6	1	
BD	8	4.6	

Figure 70.

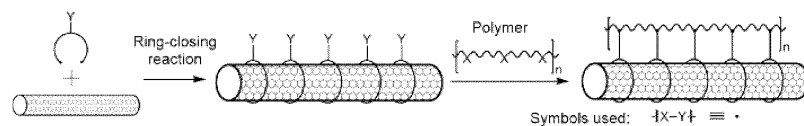
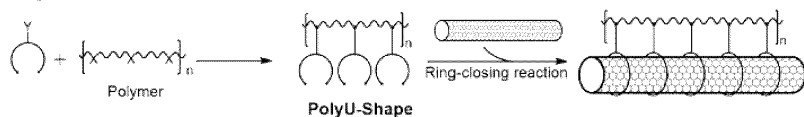
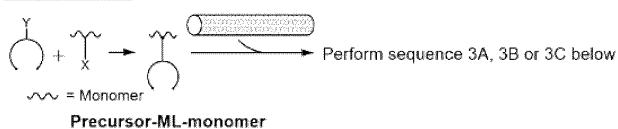
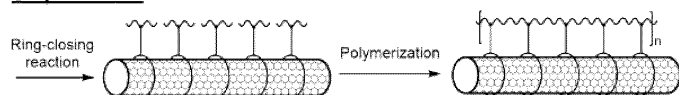
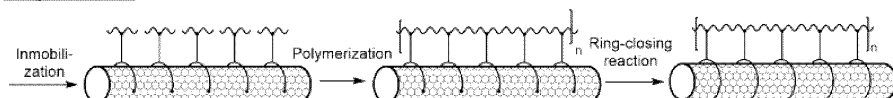
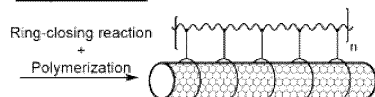
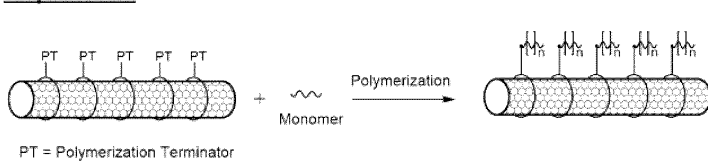
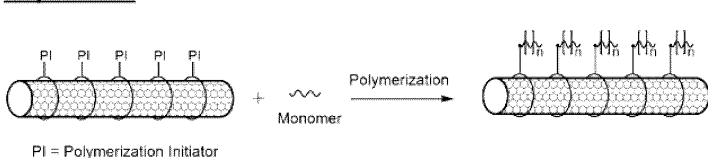
Figure 71. Different sequences of events leading to polymer composites.**Sequence 1****Sequence 2****Sequences 3****Sequence 3A****Sequence 3B****Sequence 3C****Sequence 4A****Sequence 4B**

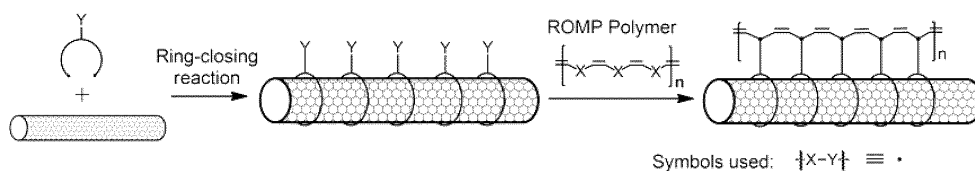
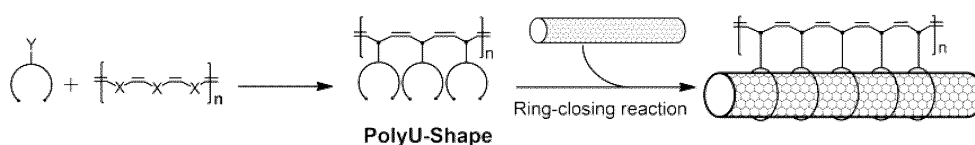
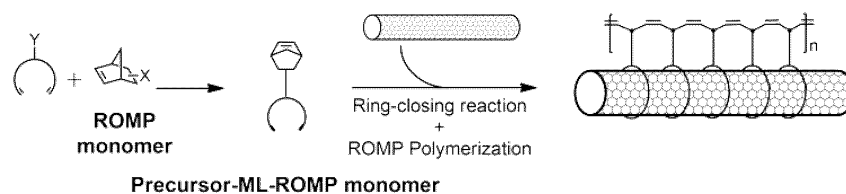
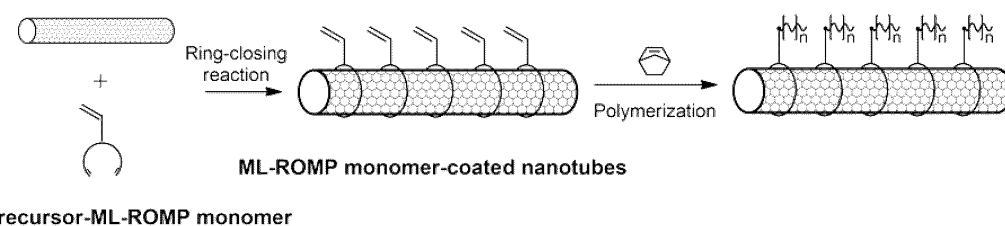
Figure 72. Different sequences of events leading to ROMP polymer-carbon nanotube composite materials.**Sequence 1, ROMP Composite****Sequence 2, ROMP Composite****Sequence 3C, ROMP Composite****Sequence 4, ROMP Composite**

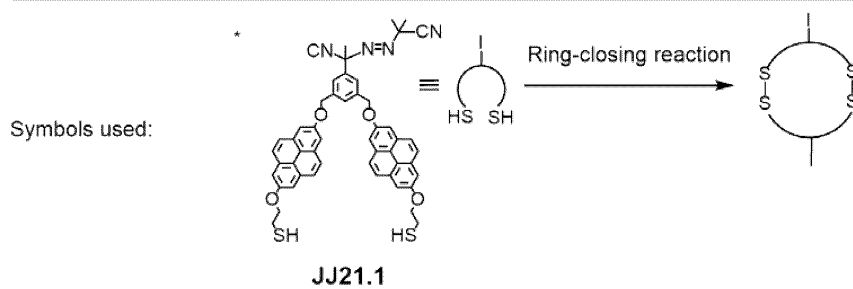
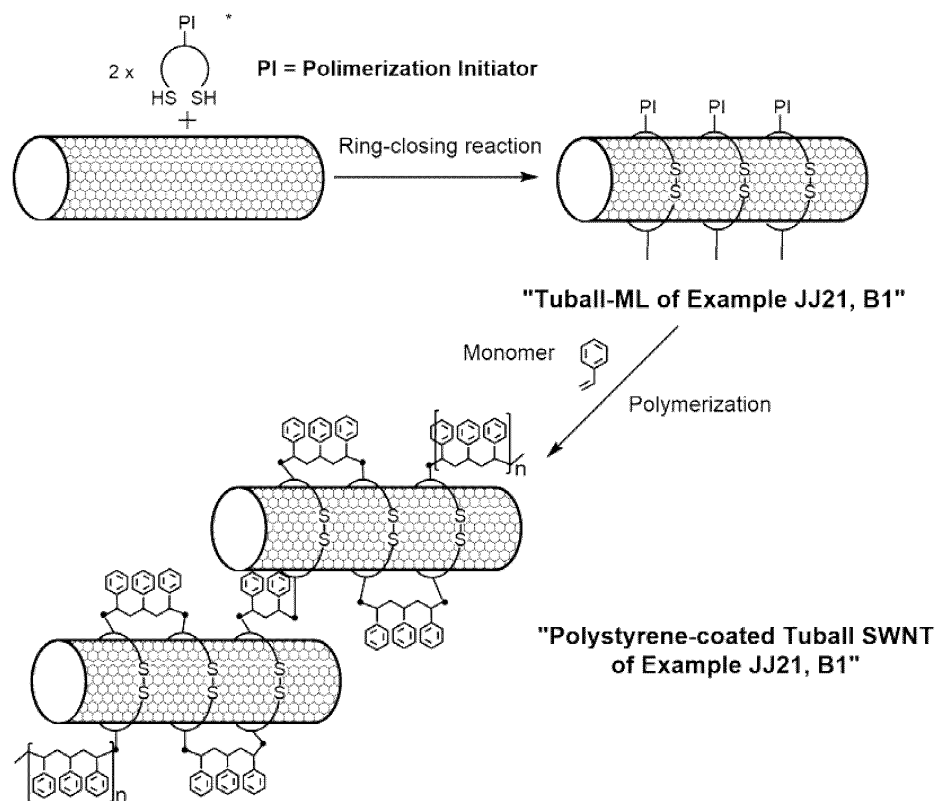
Figure 73. Sequence 1, reaction used to generate polystyrene-coated tuball SWNTs.

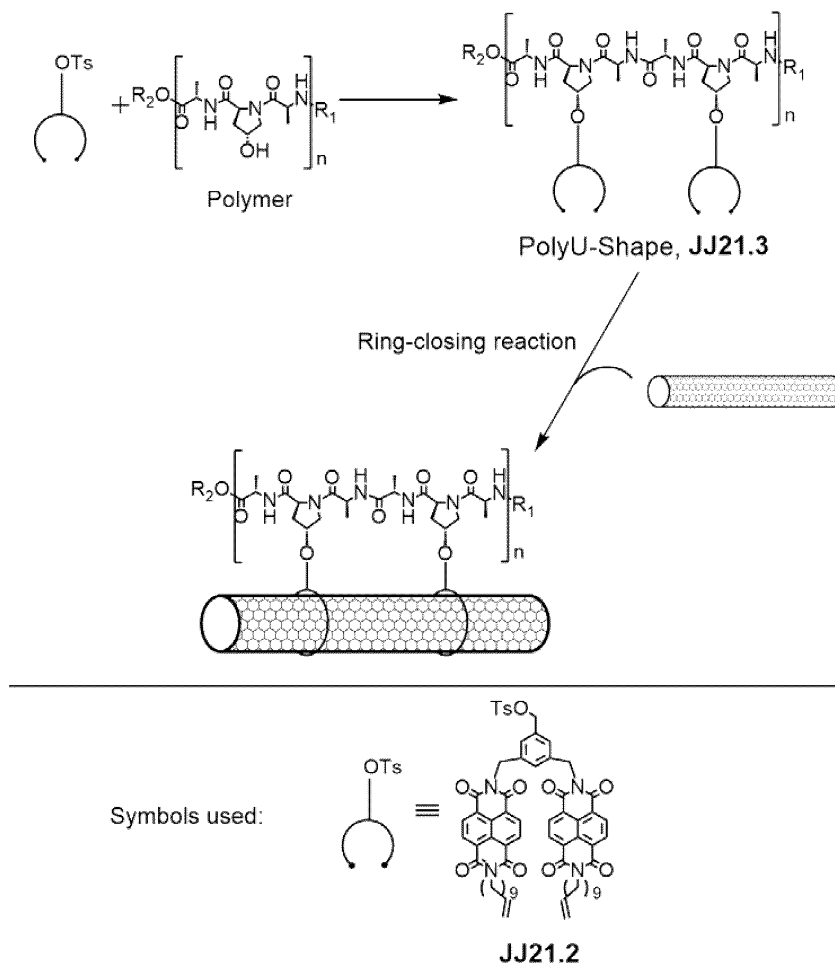
Figure 74. Sequence 2, reaction used to generate polyaminoacid-coated SWNTs.

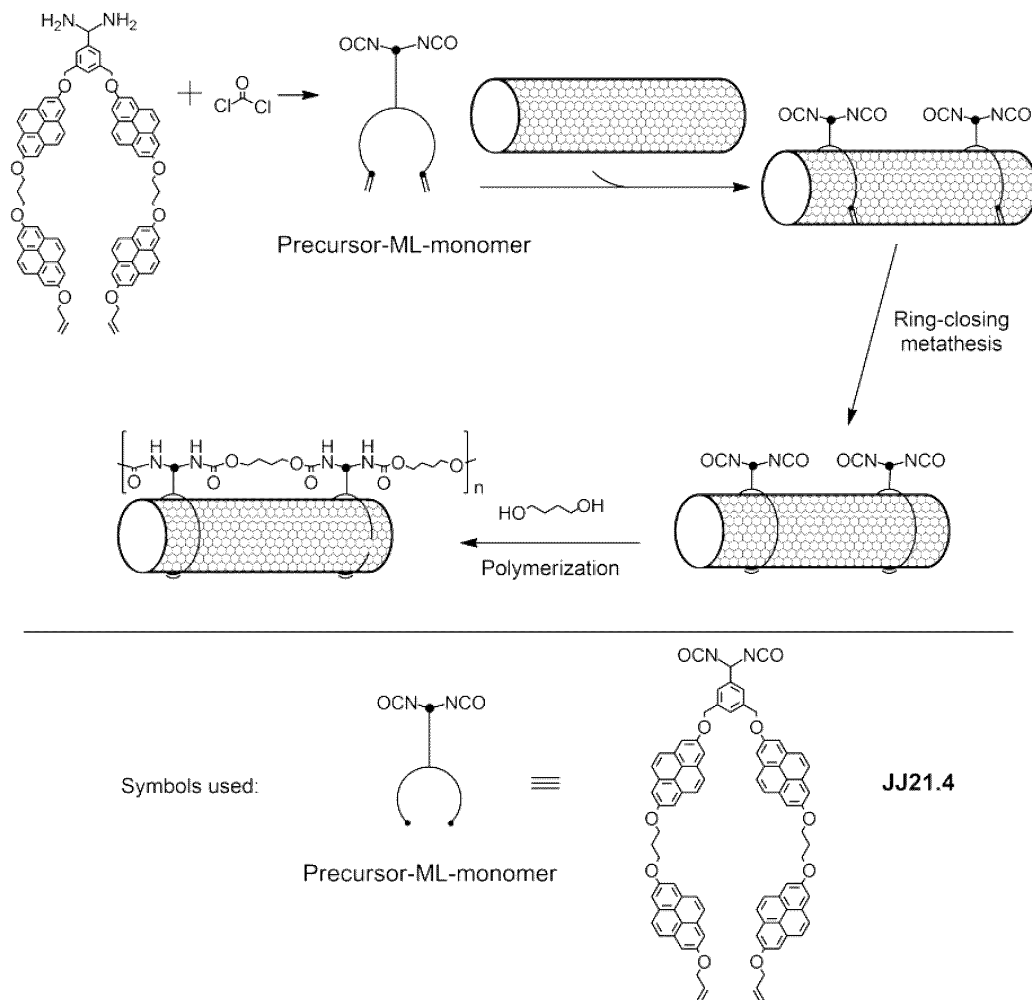
Figure 75. Sequence 3A, reaction used to generate polyurethane-coated Tuball SWNTs.

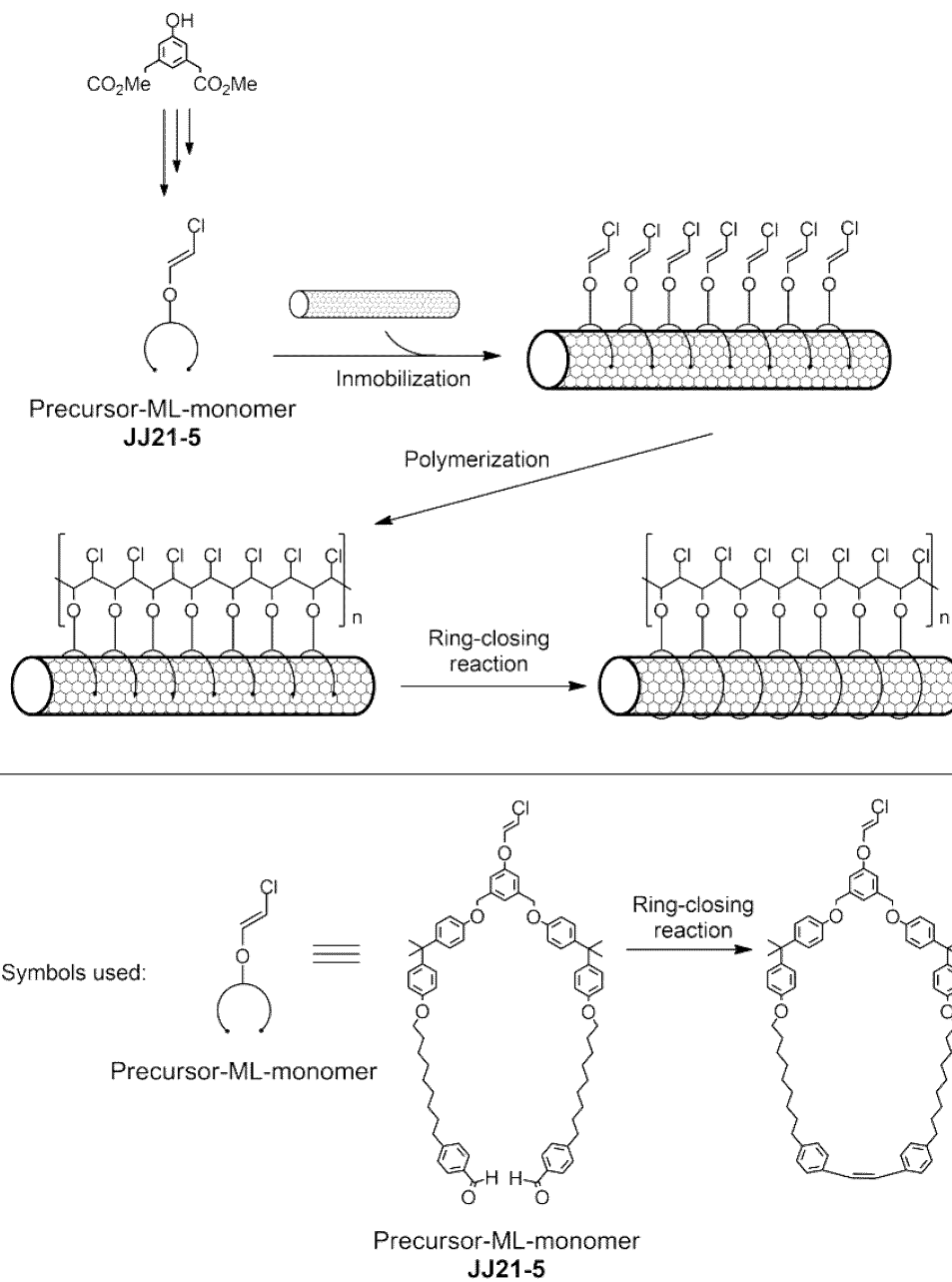
Figure 76. Sequence 3B, reaction used to generate polyvinylchloride-coated SWNTs.

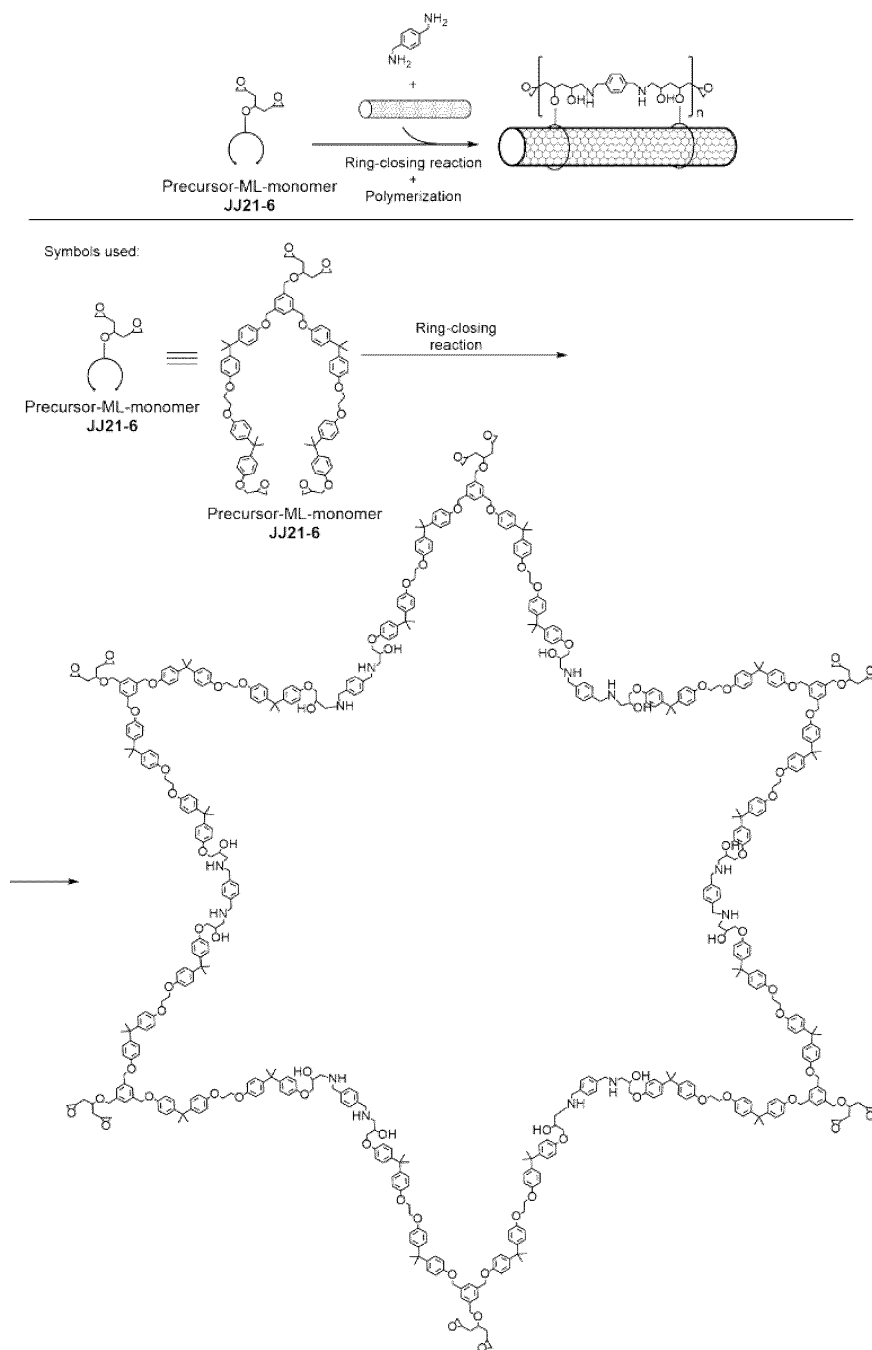
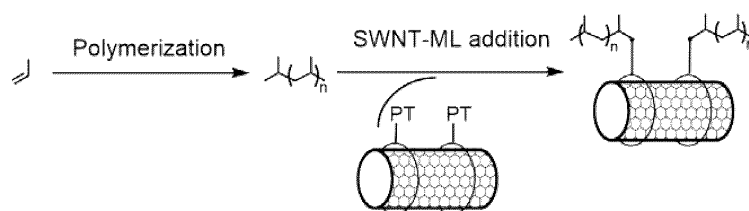
Figure 77. Sequence 3C, reaction used to generate epoxy-coated DWNTs.

Figure 78. Sequence 4, reaction used to generate polypropylene-coated SWNTs.

Symbols used:

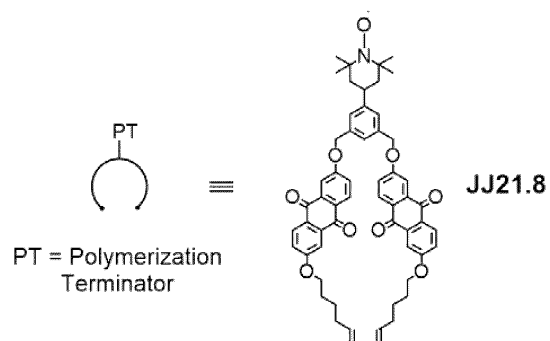
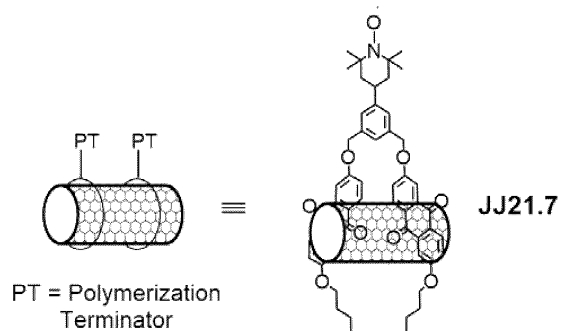


Figure 79.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
125k PS-NH ₂ + Ester MINT 0.8% SWNTs	2709.47 ± 280.88	11.09 ± 0.5

Figure 80.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
921k PS-NH ₂ neat	2112.26 ± 113	26.9 ± 1.7
921k PS-NH ₂ ester MINT_1:1	2467.14 ± 104.23	36.37 ± 5.27

Figure 81.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
907k PS-NH ₂ neat	2291.13 ± 85.65	19.87 ± 5.12
907k PS-NH ₂ 0.46% SWNTs	2241.73 ± 4.23	31.35 ± 8.56
907k PS-NH ₂ u-shape 0.23% SWNTs_a	2365.24 ± 83.98	28.5 ± 0.37
907k PS-NH ₂ u-shape 0.23% SWNTs_b	1638.97 ± 448.49	16.68 ± 2.26
907k PS-NH ₂ u-shape 0.46% SWNTs_a	2490.13 ± 175.88	28.1 ± 1.29
907k PS-NH ₂ u-shape 0.46% SWNTs_b	2568.1 ± 95.6	35.8 ± 0.13
907k PS-NH ₂ + Acid MINT 0.8%	2459.75 ± 103.02	25.33 ± 3.25
907k PS-NH ₂ + Acid MINT 0.46% SWNTs	2256.54 ± 71.39	49.1 ± 1.04
907k PS-NH ₂ + Ester MINT 0.46% SWNTs	2626.76 ± 134.47	24.52 ± 4.27
907k PS-NH ₂ u-shape 0.46% SWNTs dry	2229.79 ± 189.51	31.99 ± 5.55

Figure 82.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
907k PS-NH ₂ + 0.05% 6.5k PS-NH ₂ Acid MINT 0.52% SWNTs	2382.58 ± 111.57	36.68 ± 1.5
907k PS-NH ₂ + 0.75% 6.5k PS-NH ₂ Acid MINT 1.0 % SWNTs	2448.77 ± 70.64	35.72 ± 3.85
907k PS-NH ₂ + 2.0% 6.5k PS-NH ₂ Acid MINT 1.8 % SWNTs	2482.35 ± 242.06	32.72 ± 3.4
907k PS-NH ₂ + 5.0% 6.5k PS-NH ₂ Acid MINT 3.7 % SWNTs	2988.0 ± 261.4	16.5 ± 3.3
907k PS-NH ₂ + 5.0% 6.5k PS-NH ₂ Acid MINT 1.88 % SWNTs	2657.03 ± 137.12	27.27 ± 1.37

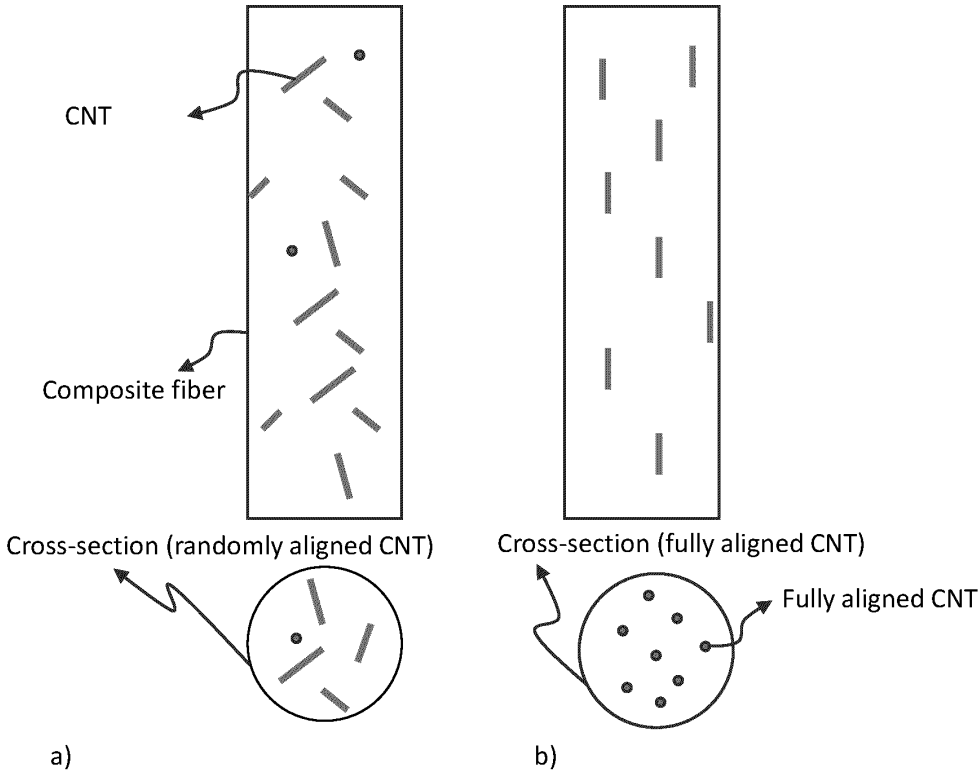


Figure 83.

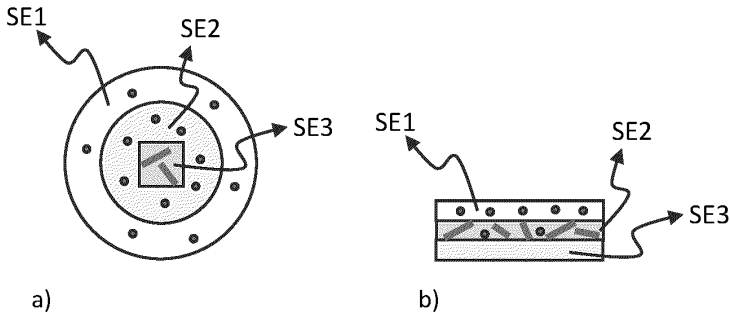


Figure 84.

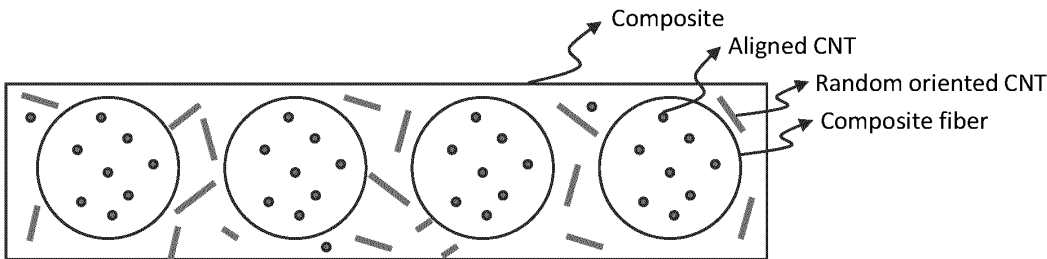


Figure 85.

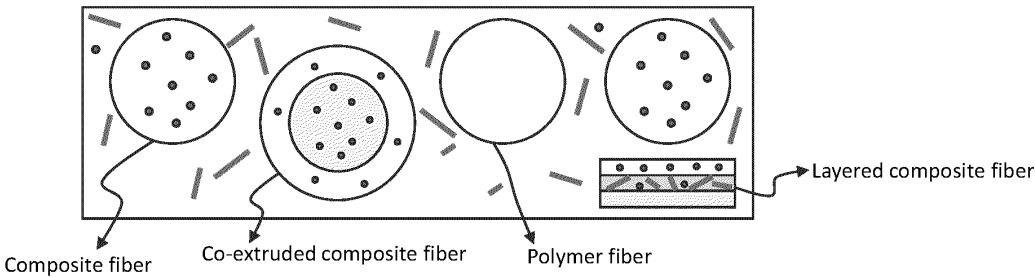


Figure 86.

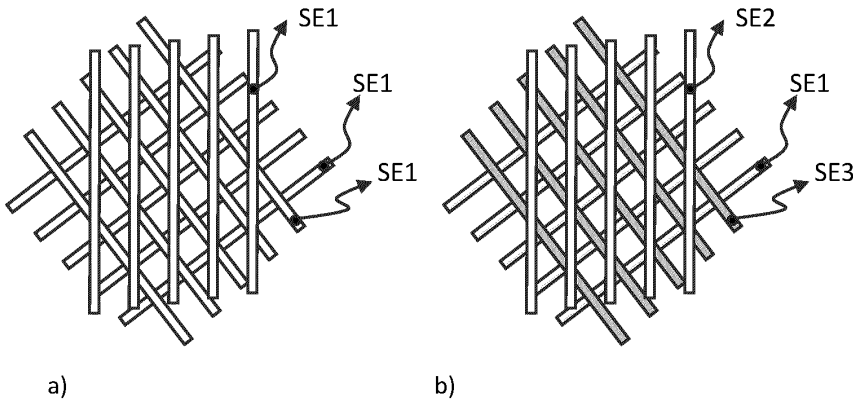


Figure 87.

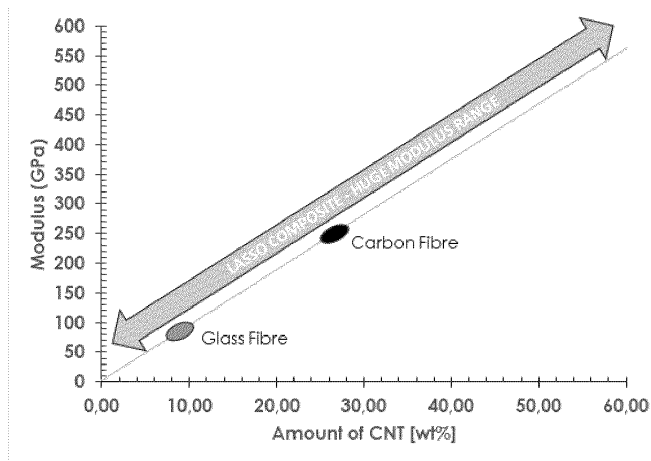


Figure 88.



Figure 89.

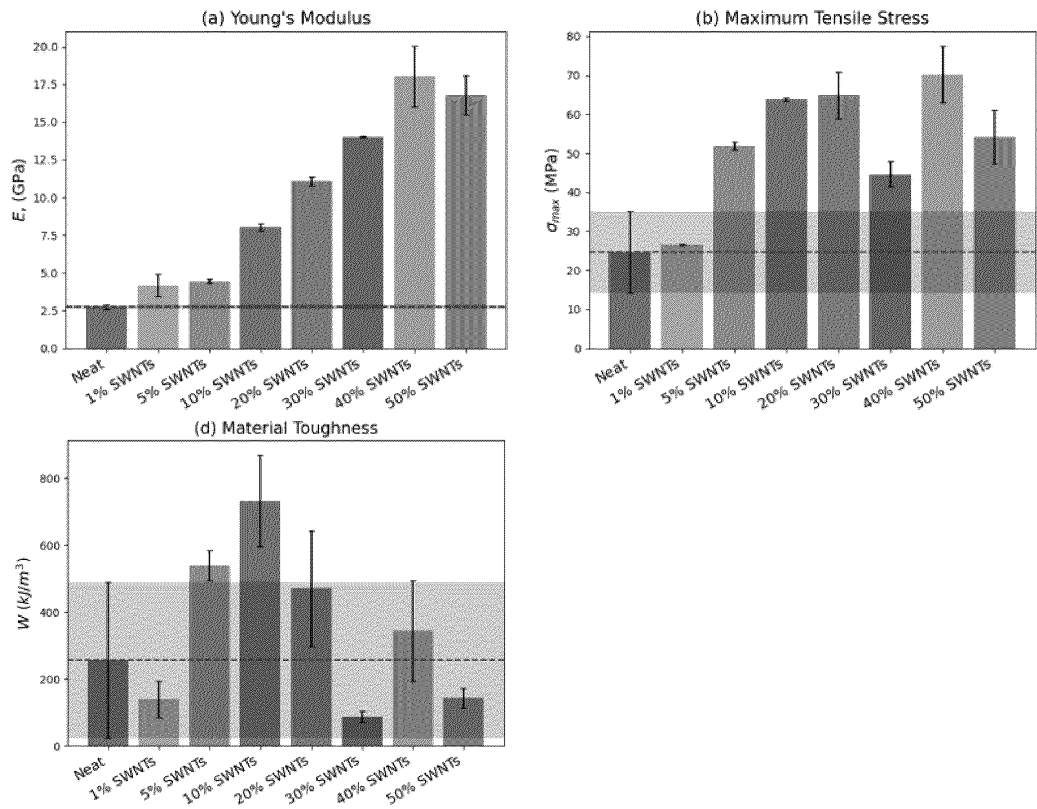


Figure 90 shows the Young Modulus, the Maximum Tensile Strength and the Toughness of 3D printed PLA samples containing from 0% to 50% of SWNTs.

Figure 91.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
125k PS-NH ₂ + Ester MINT 0.8% SWNTs	2709.47 ± 280.88	11.09 ± 0.5

Figure 92

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
921k PS-NH ₂ neat	2112.26 ± 113	26.9 ± 1.7
921k PS-NH ₂ ester MINT_1:1	2467.14 ± 104.23	36.37 ± 5.27

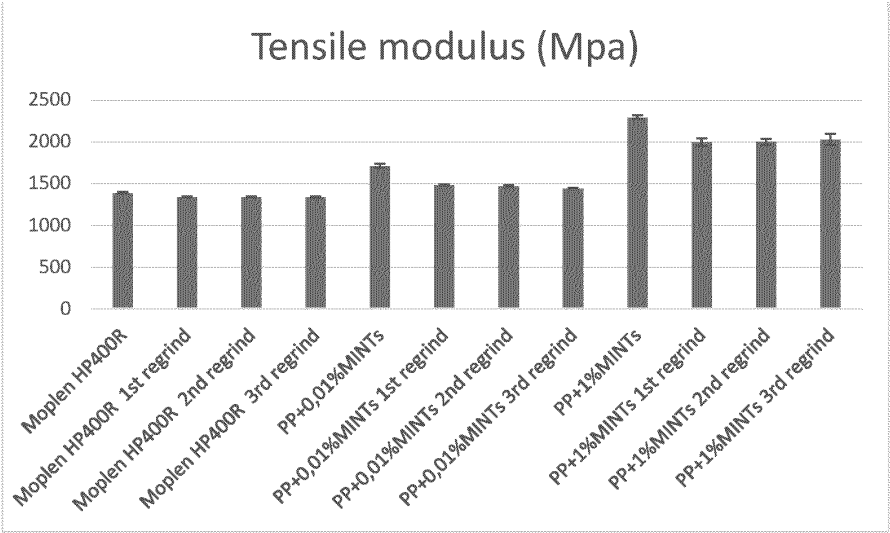
Figure 93.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
907k PS-NH ₂ neat	2291.13 ± 85.65	19.87 ± 5.12
907 k PS-NH ₂ 0.46% SWNTs	2241.73 ± 4.23	31.35 ± 8.56
907k PS-NH ₂ u-shape 0.23% SWNTs_a	2365.24 ± 83.98	28.5 ± 0.37
907k PS-NH ₂ u-shape 0.23% SWNTs_b	1638.97 ± 448.49	16.68 ± 2.26
907k PS-NH ₂ u-shape 0.46% SWNTs_a	2490.13 ± 175.88	28.1 ± 1.29
907k PS-NH ₂ u-shape 0.46% SWNTs_b	2568.1 ± 95.6	35.8 ± 0.13
907k PS-NH ₂ + Acid MINT 0.8%	2459.75 ± 103.02	25.33 ± 3.25
907k PS-NH ₂ + Acid MINT 0.46% SWNTs	2256.54 ± 71.39	49.1 ± 1.04
907k PS-NH ₂ + Ester MINT 0.46% SWNTs	2626.76 ± 134.47	24.52 ± 4.27
907k PS-NH ₂ u-shape 0.46% SWNTs dry	2229.79 ± 189.51	31.99 ± 5.55
907k PS-NH ₂ u-shape 0.5% SWNTs	2339.12 ± 87.59	34.2 ± 2.29

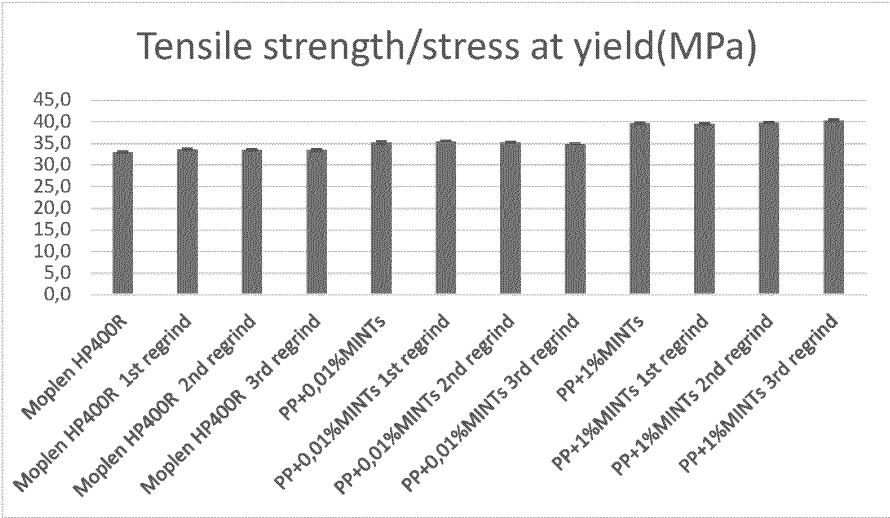
Figure 94.

Sample	Young's Modulus (MPa)	Tensile Stress (MPa)
907k PS-NH ₂ + 0.05% 6.5k PS-NH ₂ Acid MINT 0.52% SWNTs	2382.58 ± 111.57	36.68 ± 1.5
907k PS-NH ₂ + 0.75% 6.5k PS-NH ₂ Acid MINT 1.0 % SWNTs	2448.77 ± 70.64	35.72 ± 3.85
907k PS-NH ₂ + 2.0% 6.5k PS-NH ₂ Acid MINT 1.8 % SWNTs	2482.35 ± 242.06	32.72 ± 3.4
907k PS-NH ₂ + 5.0% 6.5k PS-NH ₂ Acid MINT 3.7 % SWNTs	2988.0 ± 261.4	16.5 ± 3.3
907k PS-NH ₂ + 5.0% 6.5k PS-NH ₂ Acid MINT 1.88 % SWNTs	2657.03 ± 137.12	27.27 ± 1.37

Figure 95.

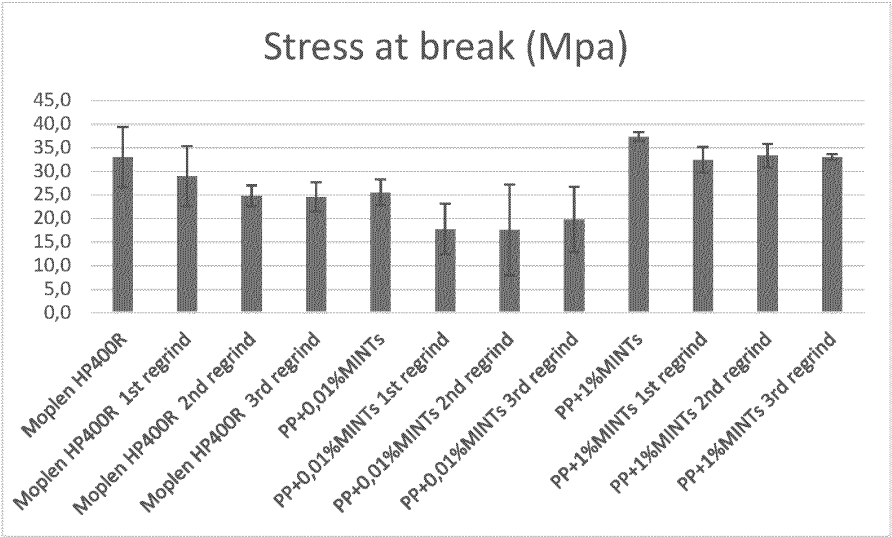


A.

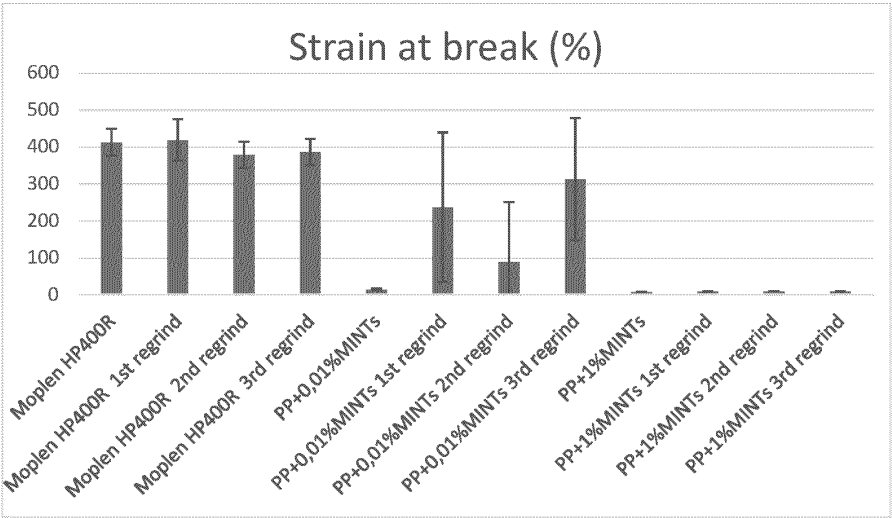


B

Figure 95, cont.

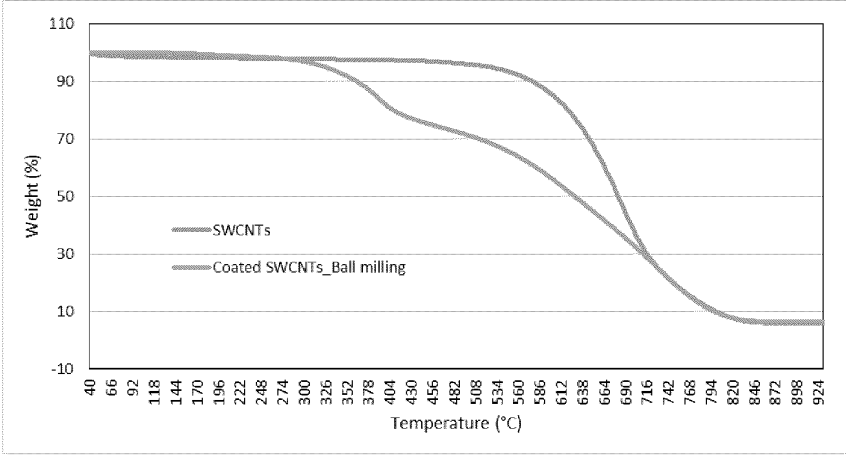


C

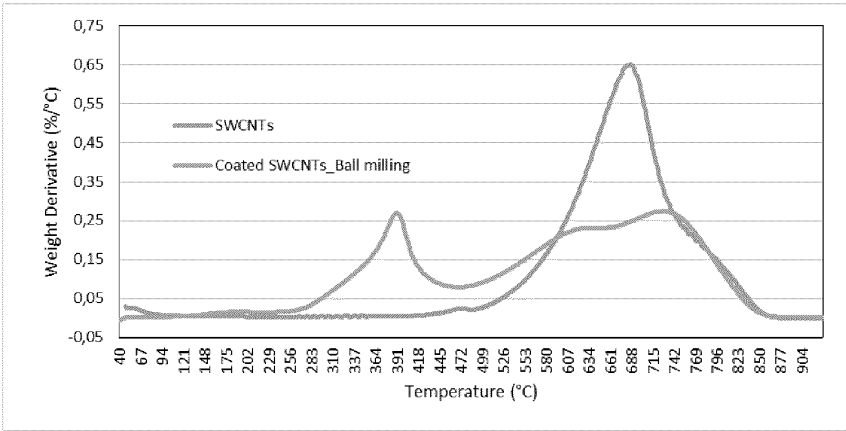


D

Figure 96.

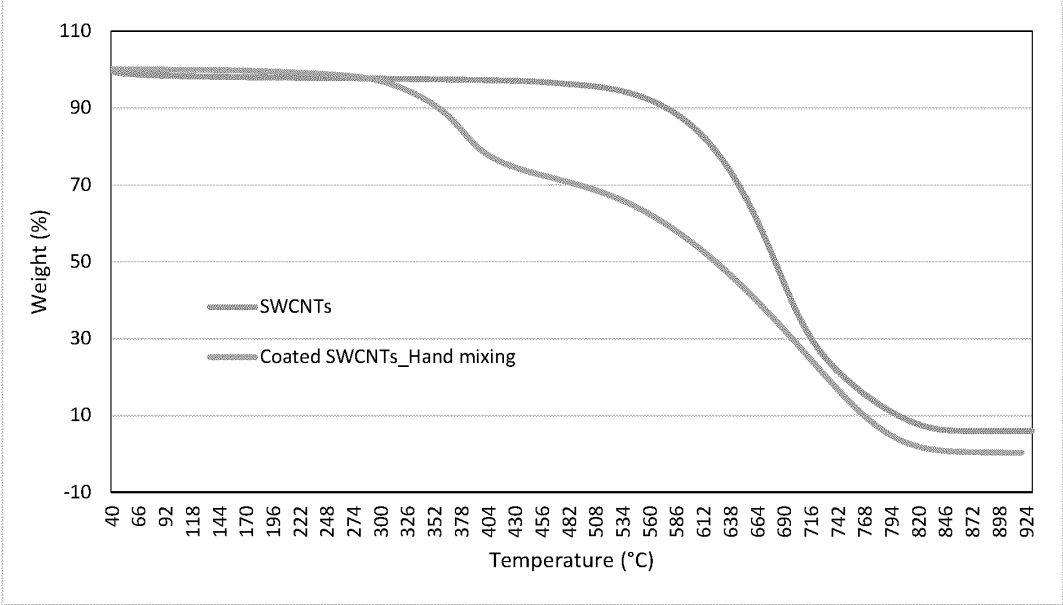


A.

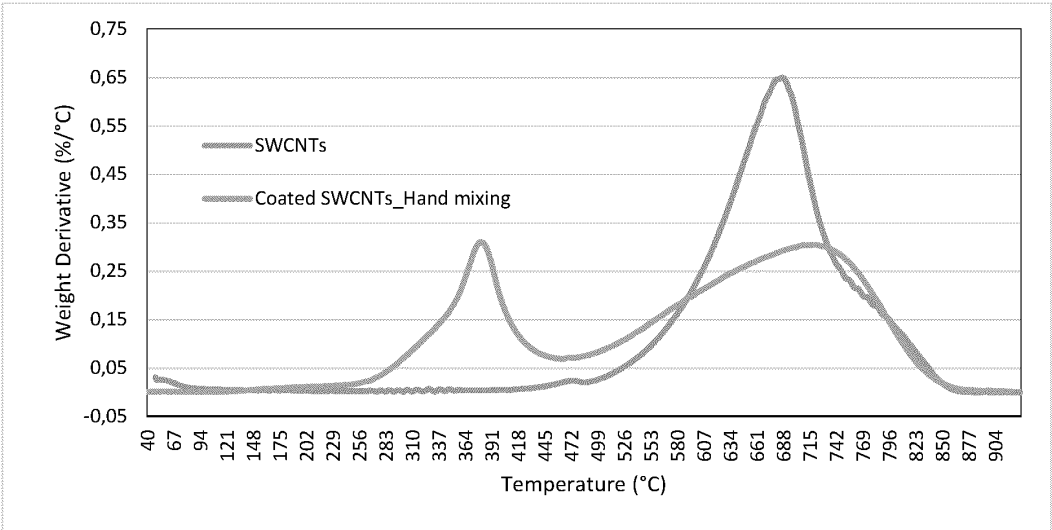


B.

Figure 97.



A.



B.

Figure 98.

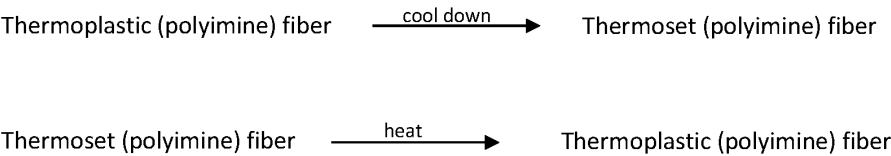


Figure 99

Material #	Molten viscosity of resin	CNT coated with lassos
1	Low viscosity	Long lasso chains and/or CNT filler concentration
2	Medium viscosity	Medium-length lasso chains and/or CNT filler concentration
3	High viscosity	Short lasso chains and/or CNT filler concentration

Figure 100

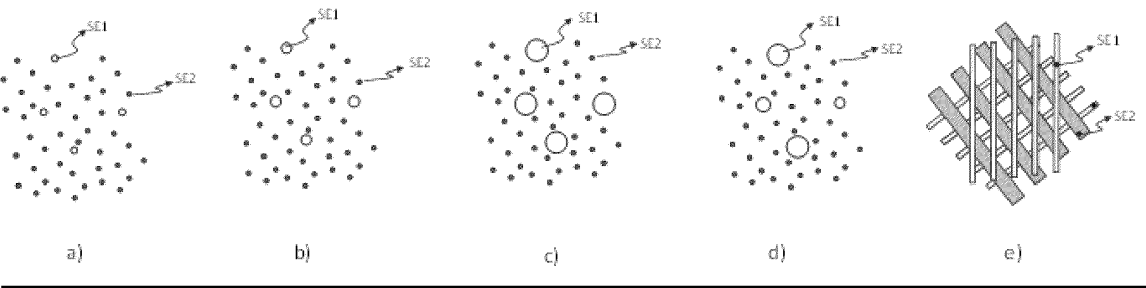


Figure 101

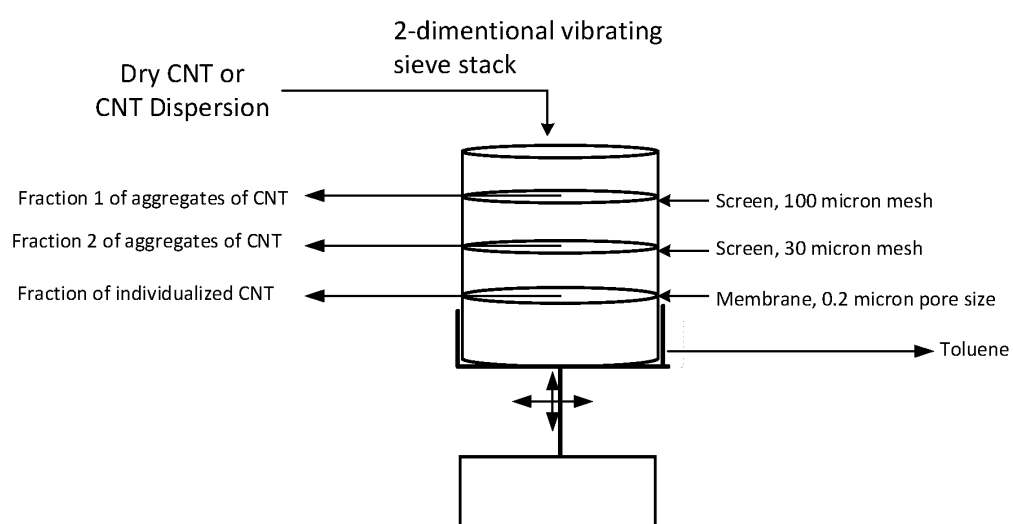


Figure 102

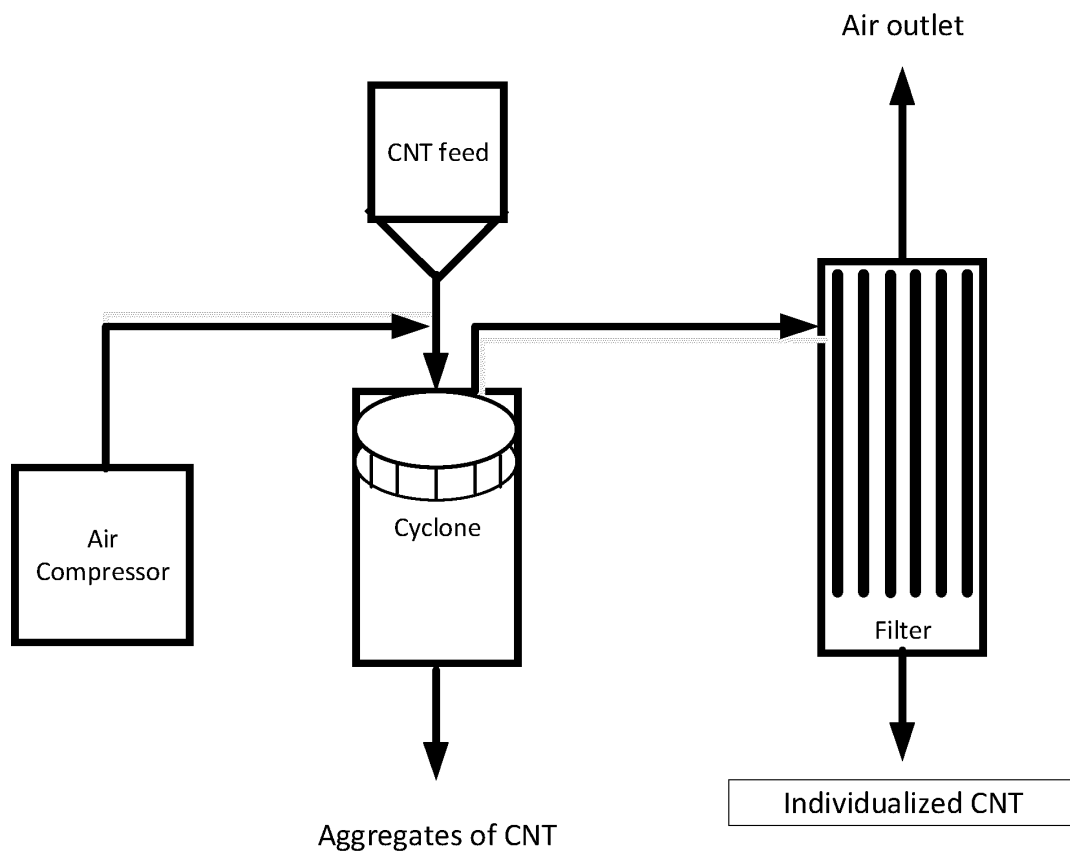


Figure 103.

