Appendix 1: Experimental Calculations

1.1 Calculations for amount of materials required to synthesis Mg-Al HTlcs

Materials	Symbol	MW (g/mol)
Mg(NO3)2.6H2O	M	256.330
Al(NO3)3.9H2O	A	375.010
Na2(CO3)2.10H2O	N	285.990

Mol Ratio

Mg	Na
2	1
Al	Na
1	1

Reaction Equations

$$2Mg(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Mg_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$

$$2Al(NO_3)_3 \cdot 9H_2O + 3Na_2(CO_3) \cdot 10H_2O \rightarrow 2Al(OH) \cdot CO_3 + 6NaNO_3 + 46H_2O + H_2CO_3$$

Calculating amount of $Mg(NO_3)_2.6H_2O$ and $Al(NO_3)_3.9H_2O$ required

Mol Ratios (M/A), MR	0.5	1	2	3	4

Total amount (M +A)	50	g

Take: M = x A = y

x + y = 50 g

Eq (1)

Mol ratio	=	x/256.330
		y/375.010

x = MR*256.330y/375.010

Mol Ratio (MR) =	0.5

x = 0.342 y **Eq (2)**

MR =	1

x = 0.684 y

Eq (3)

Substitute **(2)** into **(1)**

1.342 y = 50

y1 = 37.264 g

x1 = 12.736 g

Substitute **(3)** into **(1)**

1.684 y = 50

y2 = 29.700

x2= 20.300

MR =	2

x = 1.367 y

Eq (4)

MR =	3

x = 2.051 y

Eq (5)

Substitute **(4)** into **(1)**

2.367 y = 50

y3 = 21.123 g

x3 = 28.877 g

3.051 y = 50

y4 = 16.390

x4 = 33.610

MR =	4

x = 2.734 y

Eq (6)

Substitute **(6)** into **(1)**

3.734 y = 50

y5 = 13.390 g

x5 = 36.610 g

Calculation for amount of $Na_2CO_3.10H_2O$ required

Equations

$$2Mg(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Mg_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$

$$2Al(NO_3)_3 \cdot 9H_2O + 3Na_2(CO_3) \cdot 10H_2O \rightarrow 2Al(OH) \cdot CO_3 + 6NaNO_3 + 46H_2O + H_2CO_3$$

Mol ratios

Mg : Na	1	1
Al : Na	2	3

Materials	Symbol	MW (g/mol)
Mg(NO3)2.6H2O		256.33
Al(NO3)3.9H2O	y	375.01
Na2(CO3)2.10H2O	z	285.99

Amount of $Na_2CO_3.10H_2O$ required

Mg/Na = 1

$$\frac{x \,/\, 256 \cdot 33}{z_1 \,/\, 285 \cdot 33} = 1$$

x = 0.896 z_1

z_1 = 1.116 x

Al/Na = 0.67

$$\frac{y \,/\, 375 \cdot 01}{z_2 \,/\, 285 \cdot 99} = 0.67$$

z_2 = 1.138 y

Total Na2CO3.10H2O (z) required $z = z_1 + z_2$

$$z = 1.116x + 1.138y$$

Materials Required :

Mol Ratio	M (g)	A(g)	N (g)	N (extra 10%)
0.5	12.736	37.264	56.620	62.282
1	20.300	29.700	56.453	62.099
2	28.877	21.123	56.265	61.891
3	33.610	16.390	56.161	61.777
4	36.610	13.390	56.095	61.704

1.2 Calculations for amount of materials required to synthesis Ni-Mg-Al HTlcs

Reaction Equation:

$$2Mg(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Mg_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$
$$2Al(NO_3)_3 \cdot 9H_2O + 3Na_2(CO_3) \cdot 10H_2O \rightarrow 2Al(OH) \cdot CO_3 + 6NaNO_3 + 46H_2O + H_2CO_3$$
$$2Ni(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Ni_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$

Materials	Symbol	MW (g/mol)
Mg(NO3)2.6H2O	x	256.330
Al(NO3)3.9H2O	y	375.010
Na2(CO3)2.10H2O	z	285.990
Ni(NO3)2.6H2O	w	290.810

Mol Ratio **Ni/Mg/Al** **= 2:1:1** Total weight = 1242.62 g

Total weight used w+x+y 50 g

Weight for each material, w $\frac{\text{Molar ratio X MW}}{\text{Total weight}}$ X 50g

Fraction of total weight for each material

w = 23.403 g
x = 10.314 g
y = 15.089 g

Mol Ratio **Ni/Mg/Al** **= 1:2:1** Total weight = 1178.48 g

Total weight used w+x+y 50 g

Weight for each material, w $\frac{\text{Molar ratio X MW}}{\text{Total weight}}$ X 50g

Fraction of total weight for each material

w = 12.338 g
x = 21.751 g
y = 15.911 g

Calculation for amount of $Na_2CO_3.10H_2O$ required

$$2Mg(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Mg_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$
$$2Al(NO_3)_3 \cdot 9H_2O + 3Na_2(CO_3) \cdot 10H_2O \rightarrow 2Al(OH) \cdot CO_3 + 6NaNO_3 + 46H_2O + H_2CO_3$$
$$2Ni(NO_3)_2 \cdot 6H_2O + 2Na_2(CO_3) \cdot 10H_2O \rightarrow Ni_2(OH)_2 \cdot CO_3 + 4NaNO_3 + 30H_2O + H_2CO_3$$

Mol ratios			
	Mg : Na	1	1
	Al : Na	2	3

Materials	Symbol	MW (g/mol)
Mg(NO3)2.6H2O	x	256.33
Al(NO3)3.9H2O	y	375.01
Na2(CO3)2.10H2O	z	285.99
Ni(NO3)2.6H2O	w	290.810

Amount of $Na_2CO_3.10H_2O$ required

Mg/Na = 1

$$\frac{x \,/256 \cdot 33}{z_1 \,/285 \cdot 33} = 1$$

Al/Na = 0.67

$$\frac{y \,/375 \cdot 01}{z_2 \,/285 \cdot 99} = 0.67$$

x = 0.896 z_1

z_1 = 1.116 x

z_2 = 1.138 y

Ni/Na = 1.00

$$\frac{w \,/290 \cdot 81}{z_2 \,/285 \cdot 99} = 1$$

z_3 = 0.983 w

Total $Na_2CO_3.10H_2O$ (z) required $z = z_1 + z_2 + z_3$

$$\boxed{z = 1.116x + 1.138y + 0.983w}$$

Materials Required :

Mol Ratio	Ni (g)	M (g)	A(g)	N (g)	N (extra 10%)
Ni/Mg/Al = 2:1:1	23.403	10.314	15.089	51.687	56.856
Ni/Mg/Al = 1:2:1	12.338	21.751	15.911	54.509	59.960