Figure 1

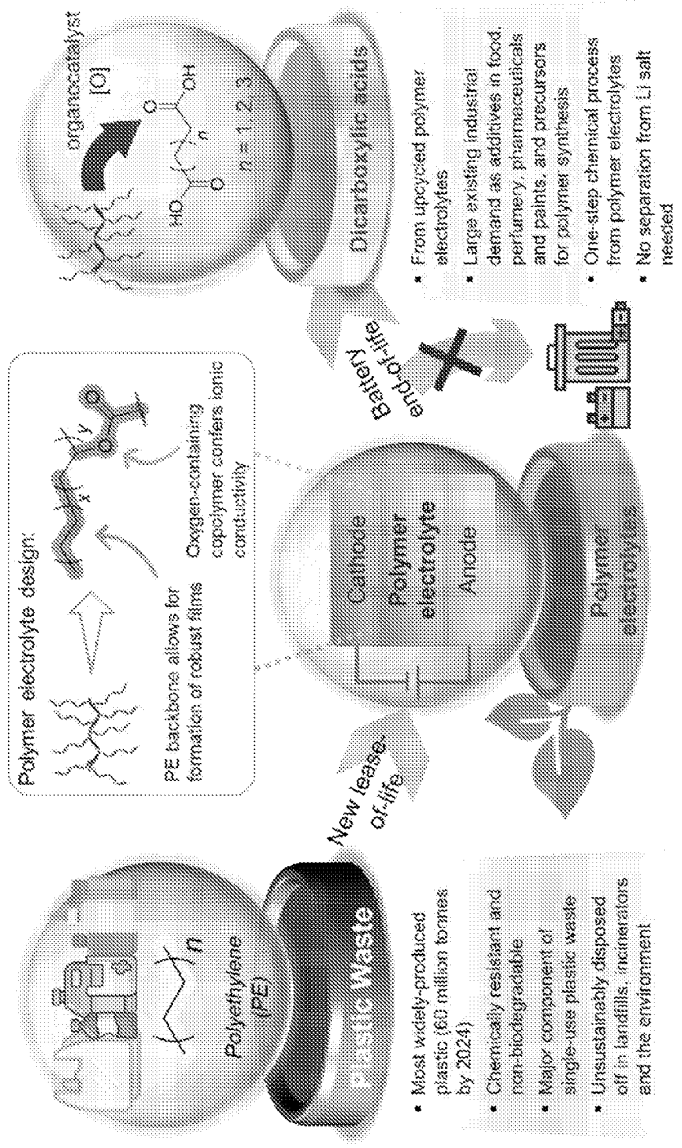

Polyethylene (PE)
Plastic Waste
Most widely-produced plastic (60 million tonnes by 2024)
Chemically resistant and non-biodegradable
Major component of single-use plastic waste
Unsustainably disposed off in landfills, incinerators and the environment
New lease-of-life
Polymer electrolyte design:
PE backbone allows for formation of robust films
Oxygen-containing copolymer confers ionic conductivity
Cathode
Polymer electrolyte
Anode
Polymer electrolytes
End-of-life
Battery
organocatalyst
[O]
n = 1, 2, 3
Dicarboxylic acids
From upcycled polymer electrolytes
Large existing industrial demand as additives in food, perfumery, pharmaceuticals and paints, and precursors for polymer synthesis
One-step chemical process from polymer electrolytes
No separation from Li salt needed

Figure 2

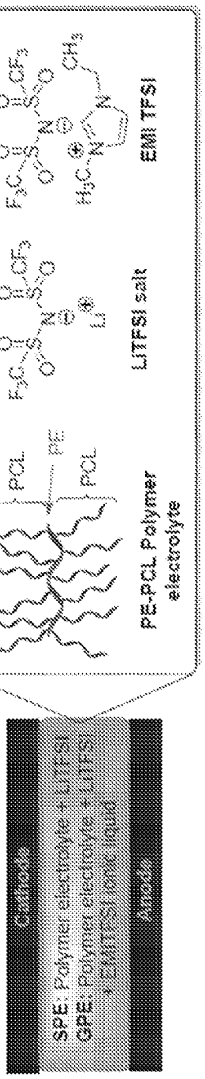


Figure 3

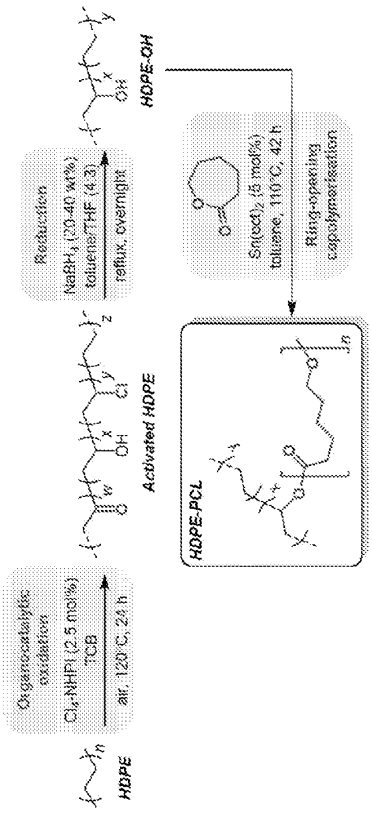
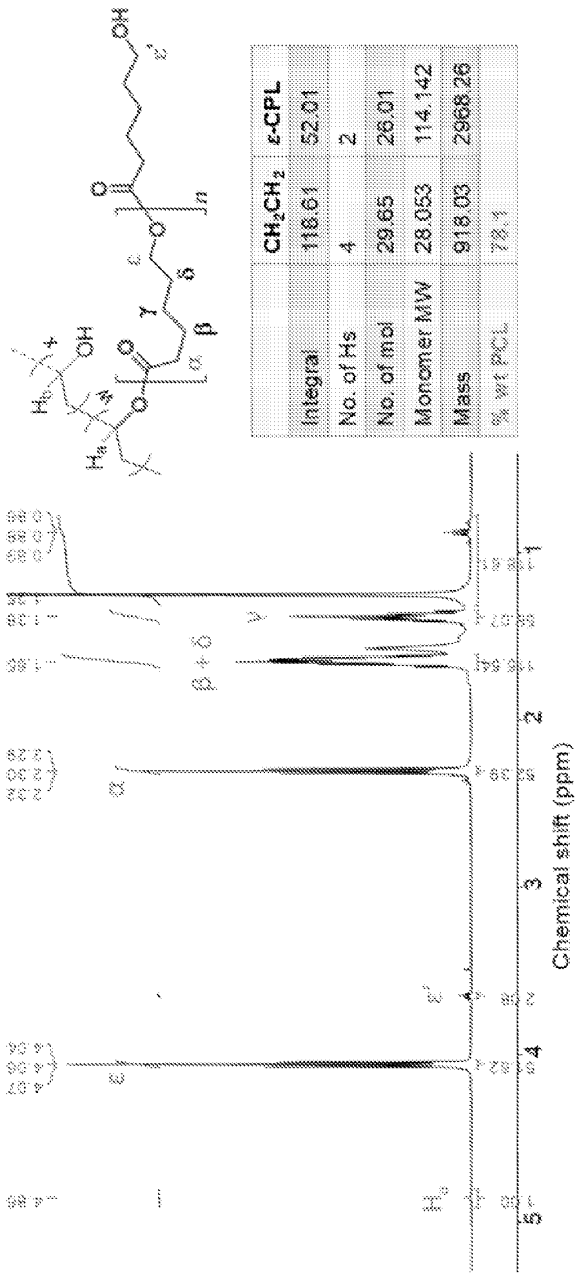


Figure 4(a)



	CH_2CH_2	ε-CPL
Integral	116.61	52.01
No. of Hs	4	2
No. of mol	29.65	26.01
Monomer MW	28.053	114.142
Mass	918.03	2968.26
% wt PCL	76.1	

Figure 4(b)

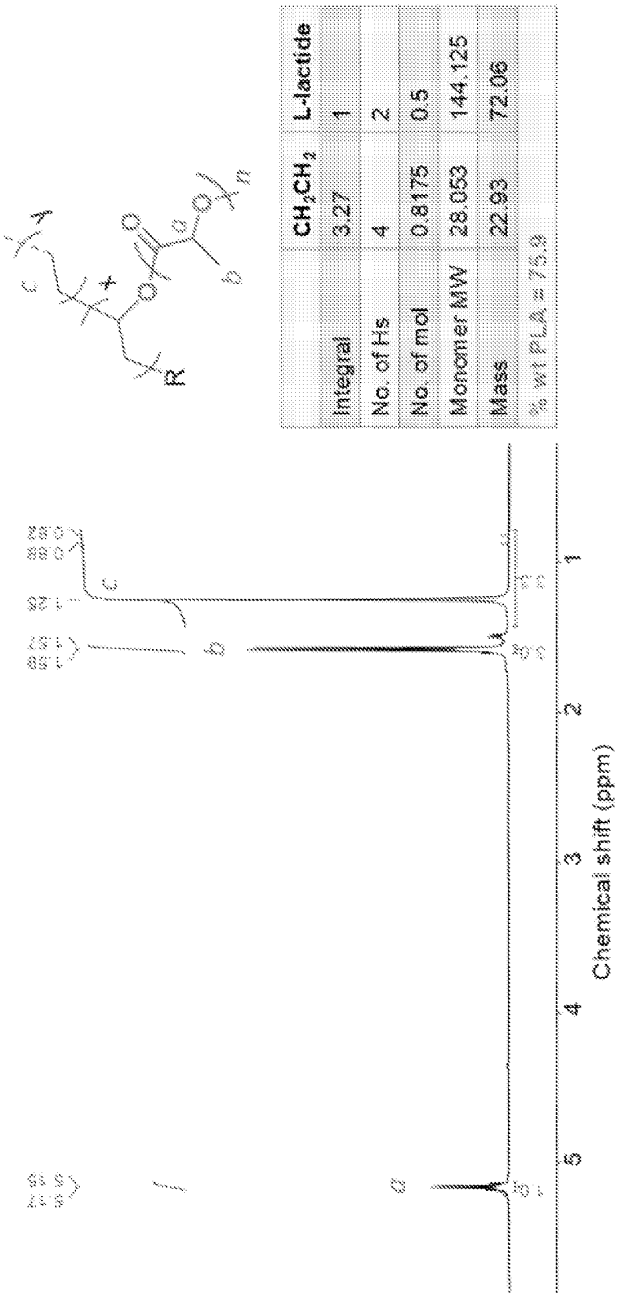

R
n
c
a
b
d
CH2CH2
L-lactide
Integral
3.27
1
No. of Hs
4
2
No. of mol
0.8175
0.5
Monomer MW
28.053
144.125
Mass
22.93
72.06
% wt PLA = 75.8
Chemical shift (ppm)

Figure 5

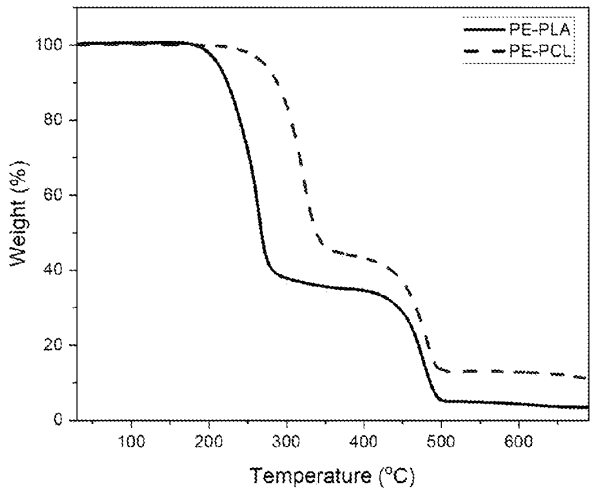

PE-PLA
PE-PCL
Weight (%)
Temperature (°C)
0
20
40
60
80
100
100
200
300
400
500
600

Figure 6(a)

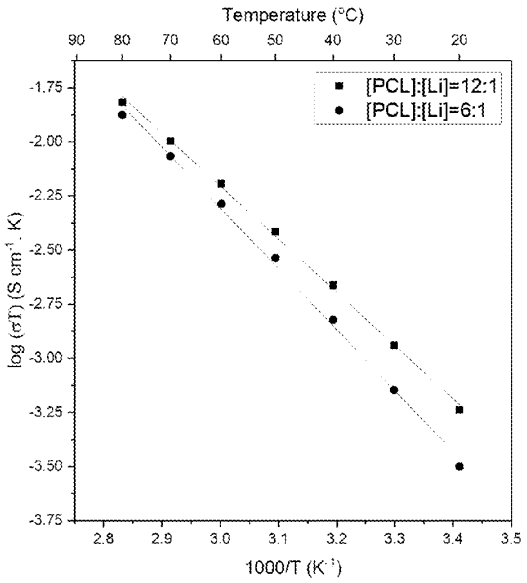


Figure 6(b)

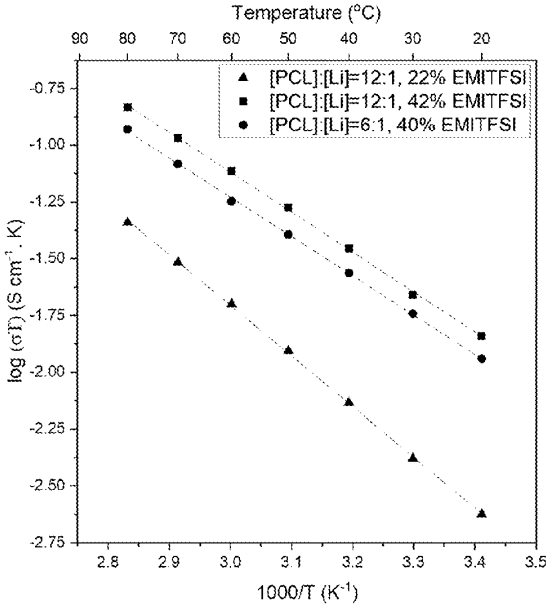


Figure 7(a)

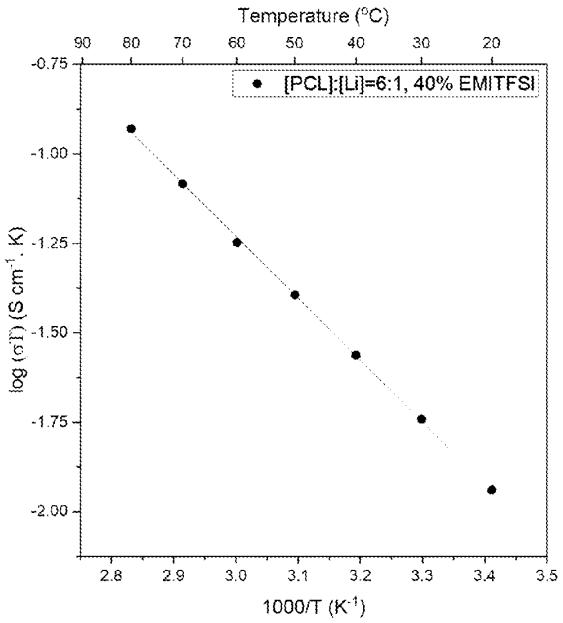


Figure 7(b)

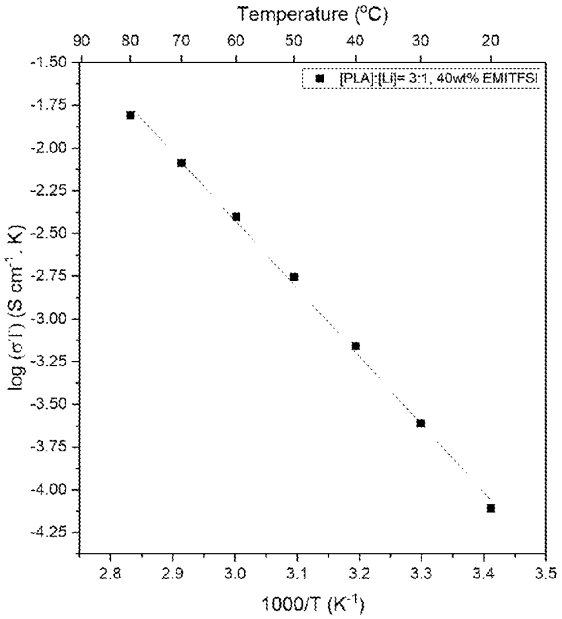


Figure 8(a)

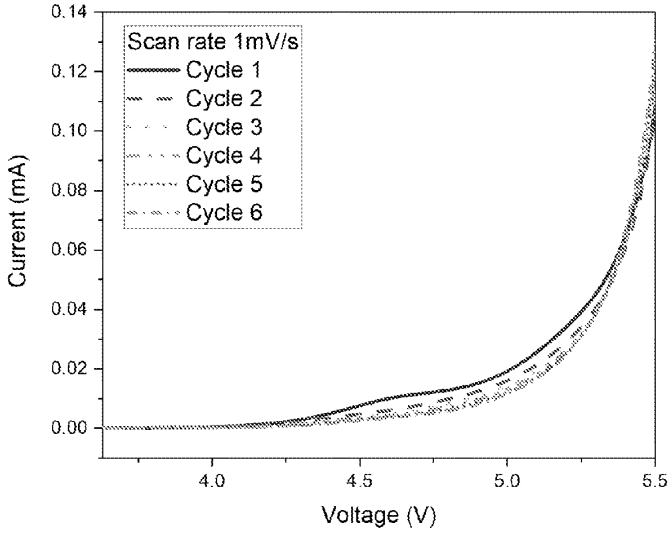


Figure 8(b)

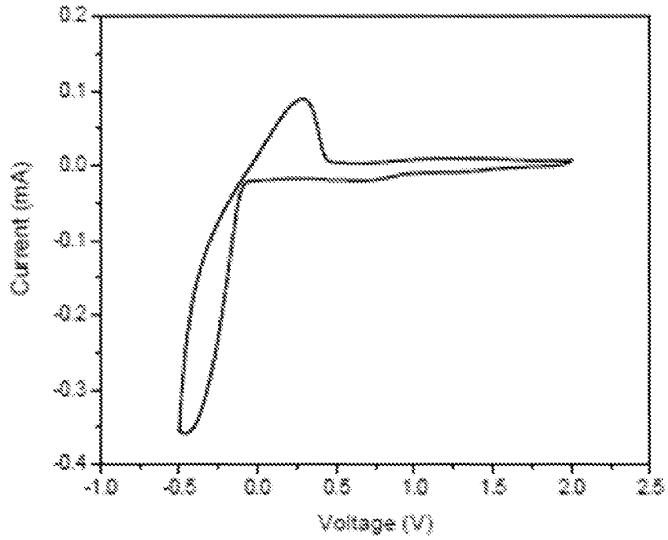


Figure 8(c)

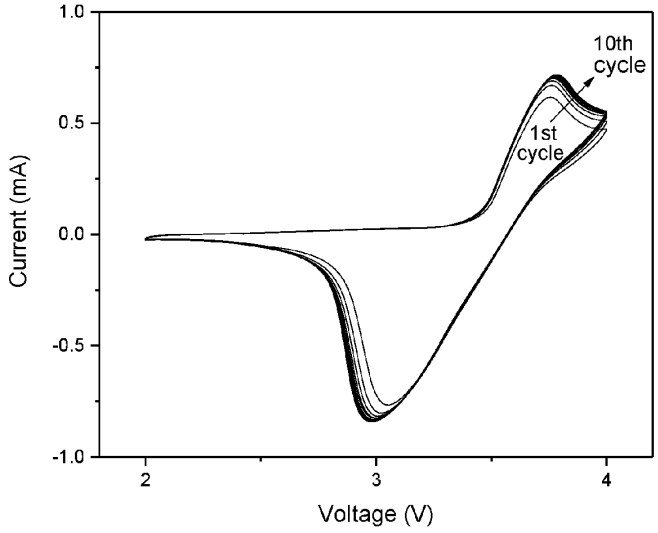


Figure 8(d)

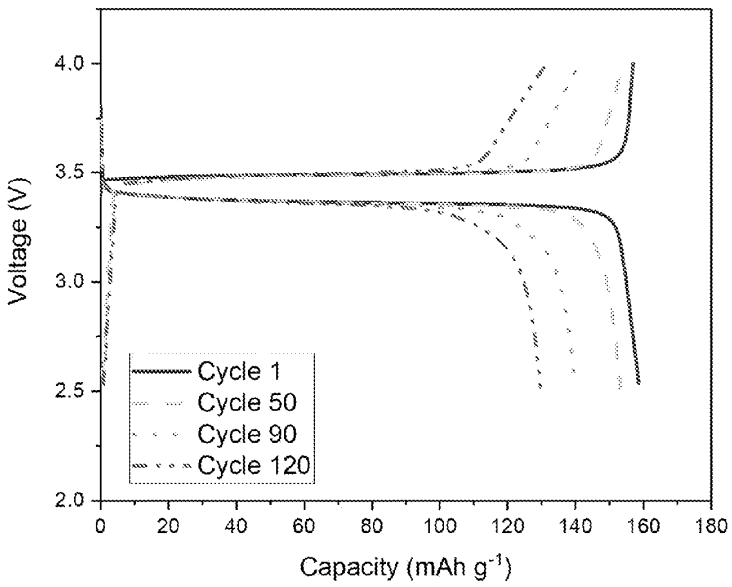


Figure 8(e)

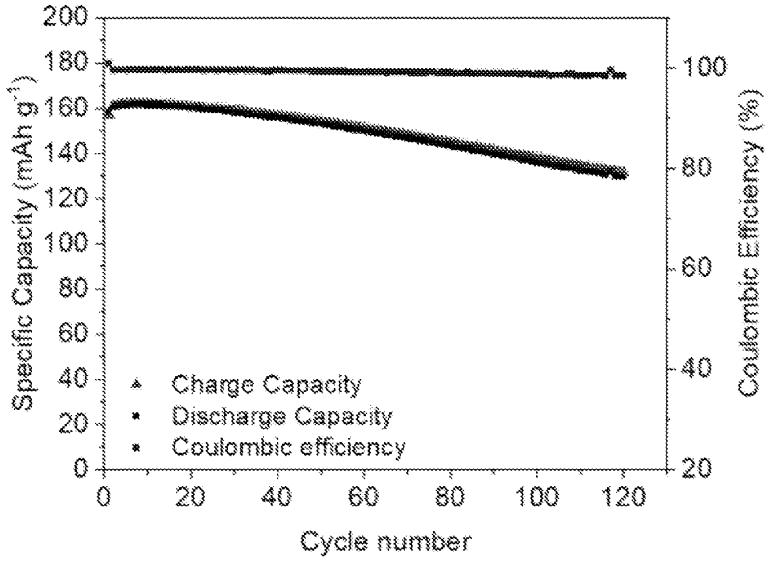


Figure 8(f)

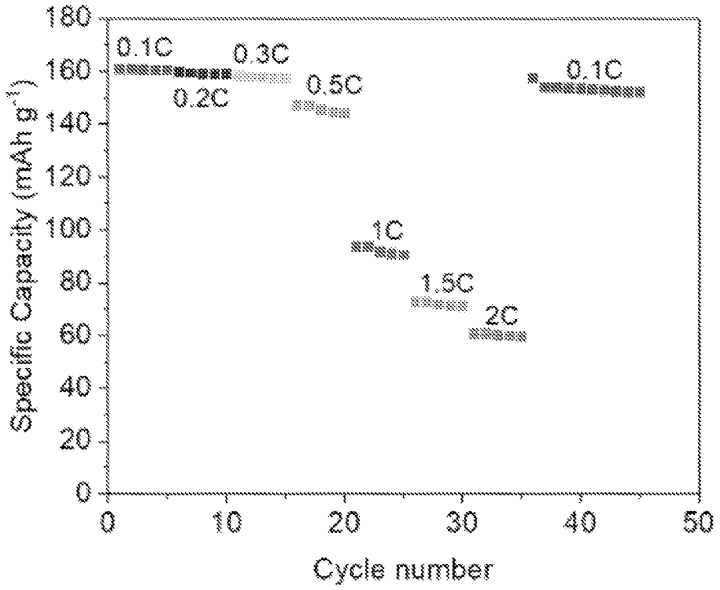


Figure 9

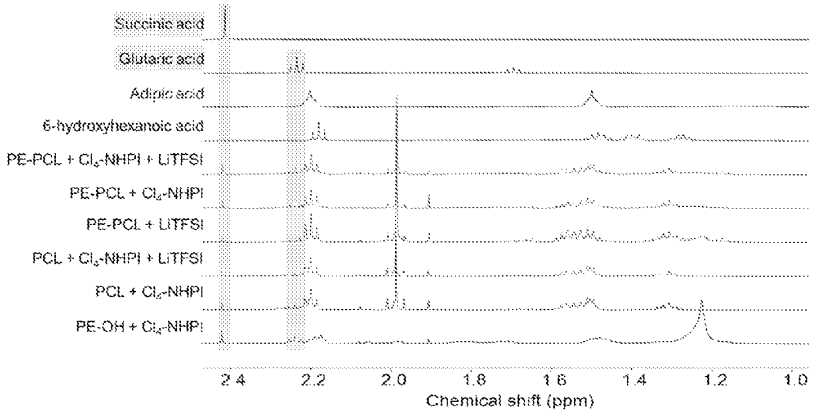
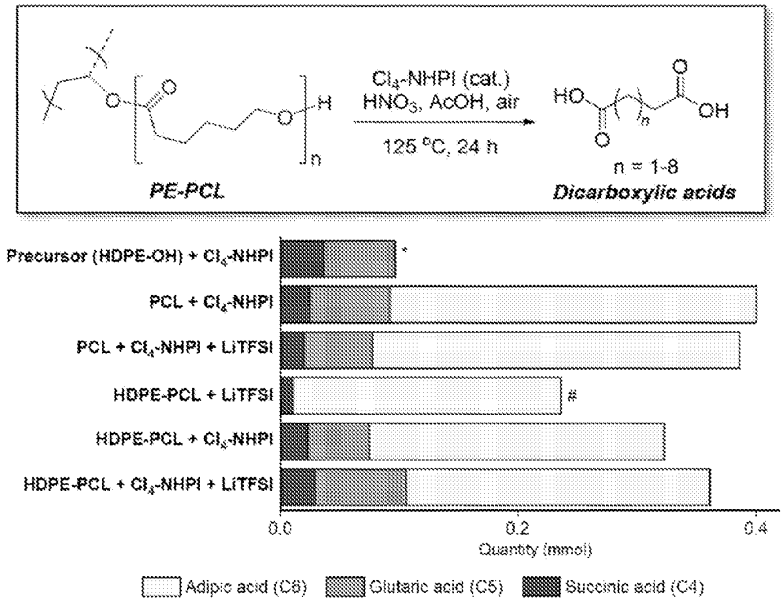


Figure 10



* Although adipic acid could be detected by ESI-MS, it was not present in sufficient quantities in the ^{1}H NMR spectrum of the HDPE-OH oxidation reaction for accurate quantification;
# Solids, mainly PE, remained at the end of the reaction, hence the products are from degradation of the PCL segment alone