Supporting Information

Graphene Triggered Catalytic Attack on Plastic Waste Produces Graphitic Shell Encapsulation on Cobalt Nanoparticles for Ferromagnetism and Stable Li^+ ion Storage

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Figure S1

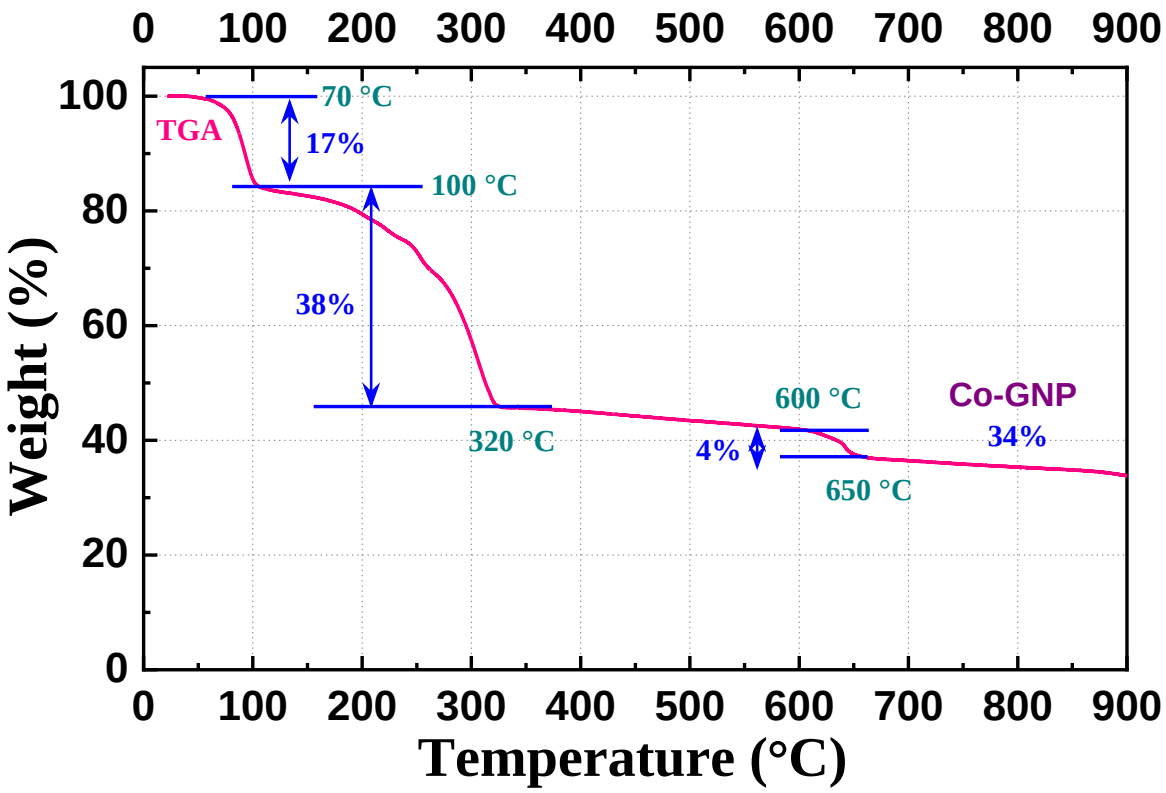

Figure S1 Thermogravimetric analysis of the mixture, contains cobalt acetate and GNP, yielded pristine Co-GNP material, carried out between 25 °C to 900 °C at 10 °C min^{-1} in Ar atmosphere.

Figure S2

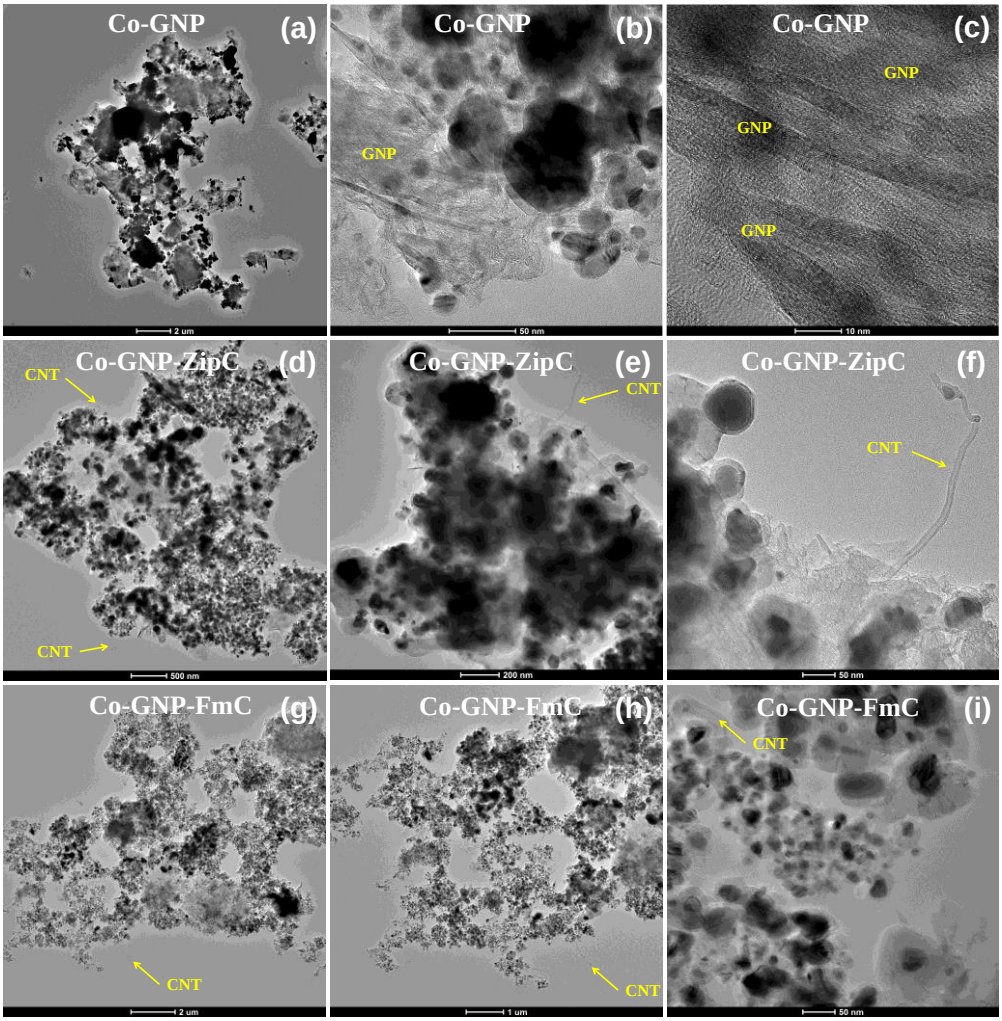

Figure S2 TEM images of (a) Pristine Co-GNP, (b) comprised cobalt nanoparticles and graphene nanoplatelets revealed without any core-shell architecture, (c) GNP sheets without cobalt nanoparticles, (d) morphological image of Co-GNP-ZipC material, (e) contained cobalt nanoparticles with carbon matrix and CNT, (f) plastic waste Ziploc cover's polyethylene produced CNT, (g) morphological image of Co-GNP-FmC material, (h) contained cobalt nanoparticles with carbon matrix and CNT and (i) plastic waste packing foam's polystyrene produced CNT.

Figure S3

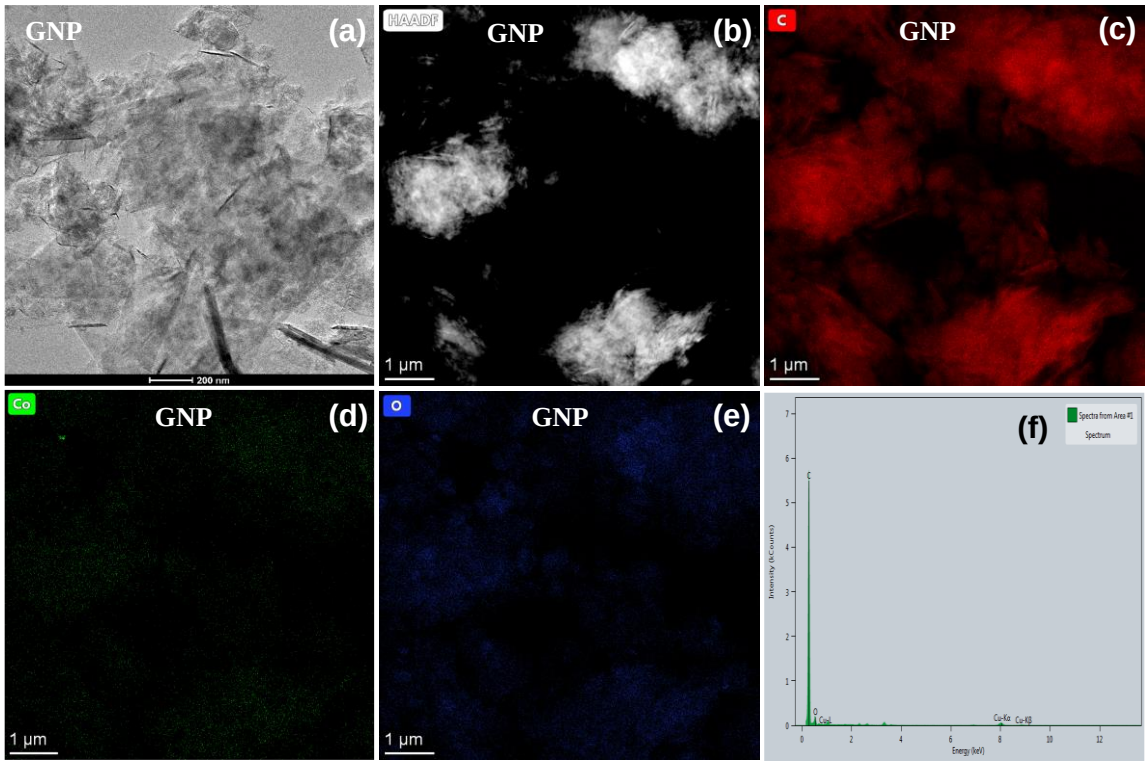

Figure S3 (a) TEM image of GNP, (b) HAADF image, simultaneous elemental mapping analyses confirm the presence of (c) carbon (C, red), (d) absence of cobalt (Co, green), (e) trace amount of oxygen (O, blue), and (f) GNP's quantified energy dispersive X-ray TEM spectrum.

Figure S4

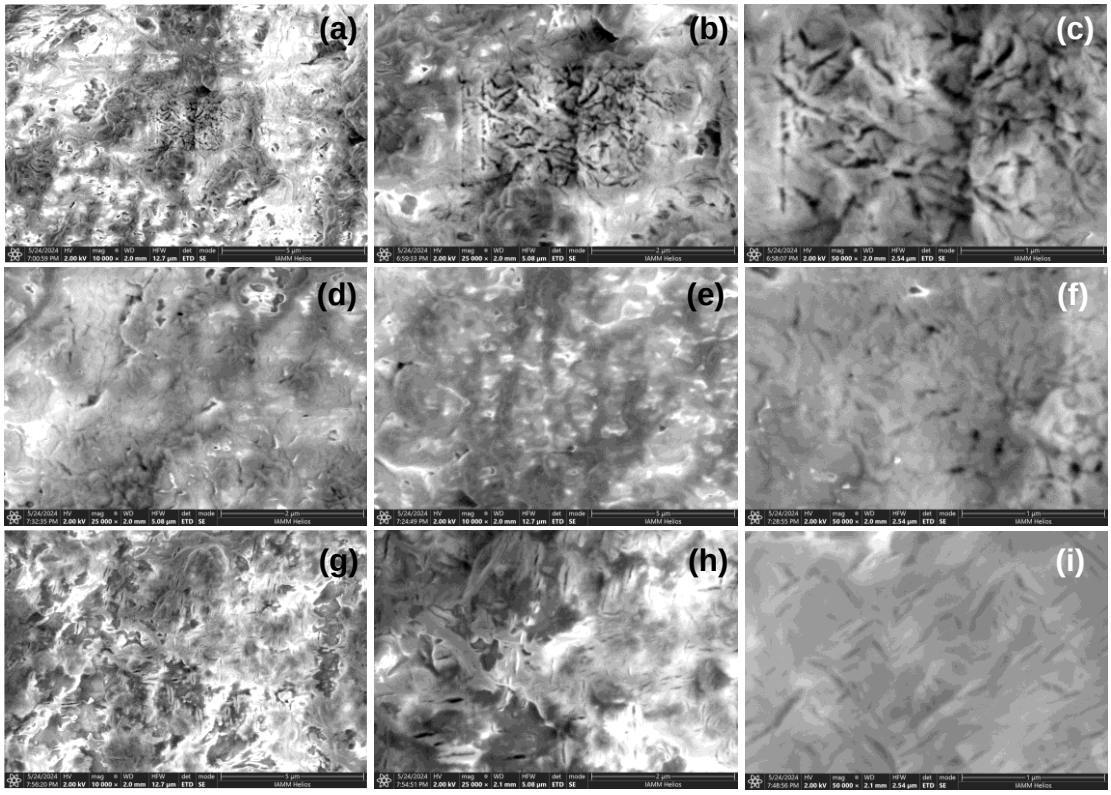

Figure S4 After cycling FESEM images of Co-GNP (a-c), Co-GNP-ZipC (d-f) and Co-GNP-FmC (g-i) materials.

Table S1. The degree of graphitization is estimated from the ratio of D-band and G-band intensities for the GNP, Co-GNP, Co-GNP-ZipC and Co-GNP-FmC materials.

Materials	Intensity of D-band (I_D)	Intensity of D-band (I_D)	R = I_D/I_G
GNP	77.8	86.3	0.9
Co-GNP	23.8	42.2	0.56
Co-GNP-ZipC	19.6	27.9	0.7
Co-GNP-FmC	58.6	56.6	1

Table S2. Experimental and fitted electrochemical impedance characteristics of (i) pristine Li vs Co-GNP, (ii) Li vs Co-GNP-ZipC and (iii) Li vs Co-GNP-FmC lithium cells, assembled with the respective electrode (Co-GNP, Co-GNP-ZipC and Co-GNP-FmC), lithium metal foil, Celgard polypropylene separator and 1M $LiPF_6$ in EC+DEC (1:1 vol%) electrolyte.

S. No	**Cell**	**Impedance components R in ohms and C in farad**	**Phase element (Φ)**	**Remarks**
(i)	Li / Co-GNP	$R_1 = 3.481$, $R_2 = 30.65$, $Rd_2 = 4.513$ $C_2 = 4.609 \times 10^{-6}$	$td_2 = 0.0935$ $s_3 = 16.98$	Fitted with simple equivalent circuit components – Revealed less charge transfer resistance – Li^+ ion intercalation and deintercalation.
(ii)	Li / Co-GNP-ZipC	$R_1 = 3.403$, $R_2 = 83.28$, $R_3 = 22.52$ $Rd_3 = 12.61$ $Q_2 = 21.29 \times 10^{-6}$ $C_3 = 57.09 \times 10^{-6}$	$a_2 = 0.8536$ $td_3 = 0.2474$ $s_4 = 20.55$	Nyquist plot fitted with complex equivalent circuit components – Having higher charge transfer resistance – Corresponding to the additional charge storage buildup – High semi-infinite linear diffusion.
(iii)	Li / Co-GNP-FmC	$R_1 = 2.265$, $R_2 = 59.33$, $R_3 = 105.8$ $Rd_3 = 4.929$ $Q_2 = 23.82 \times 10^{-6}$ $C_3 = 18.64 \times 10^{-6}$	$a_2 = 0.8734$ $td_3 = 0.030$ $s_4 = 78.12$	Nyquist plot fitted with complex equivalent circuit components – Having higher charge transfer resistance – Corresponding to the additional charge storage buildup – High semi-infinite linear diffusion.