

Supplementary Information File

Effect of Salt Variability on the Low-temperature Metal-Catalyzed Graphitization of PAN/DMSO Solutions for the Synthesizing Nanostructured Graphitic Carbon

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1. Experimental Section

1.1 Materials

Acrylonitrile ($\geq 99.0\%$), Itaconic acid ($\geq 99.0\%$), 1-Dodecanethiol ($\geq 98.5\%$), 2,2-Azobisisobutyronitrile (KOH, $\geq 98.0\%$), and DMSO ($\geq 99.0\%$) were obtained from Samchun, Republic of Korea. Lithium nitrate ($\text{LiNO}_3 \geq 99.0\%$), Calcium nitrate ($\text{Ca}(\text{NO}_3)_2 \geq 99.0\%$), and Nickel nitrate ($\text{Ni}(\text{NO}_3)_2 \geq 99.0\%$) are purchased from Sigma-Aldrich. All the chemical compounds were analytical grade and used without further purification.

2. Materials characterizations

The as-prepared materials' surface morphology, microstructural analysis, and elemental analysis of the fabricated samples were described using field emission scanning electron microscopy (FE-SEM, SUPRA40VP, Carl Zeiss, Germany) with an instrument equipped with energy-dispersive X-ray spectroscopy (EDXS) and transmission electron microscopy (TEM, JEM-2100 plus, JEOL Ltd., Japan). The phase, as well as the structure of all the samples, were studied with X-ray diffraction (XRD, Rigaku Corporation, Japan, CuK α radiation, wavelength $\lambda=0.154$ nm) in the 2θ range from 5-80° at a scan rate of 2° min⁻¹. The graphitization of all prepared samples was analyzed by Raman spectroscopy at room temperature using a Raman spectrometer (RAMANtouch) from Nanophoton, with an argon ion laser source at an excitation wavelength of 523 nm, conducted at the Gunsan National University Center for Research Facilities. FE-SEM, EDX, TEM, and XRD analyses were performed at the Center for University-wide Research Foundation (CURF), Jeonbuk National University, Jeonju, South Korea.



Figure S1: Photographic image PANs solution with different metal salt (catalyst) at

various wt%.

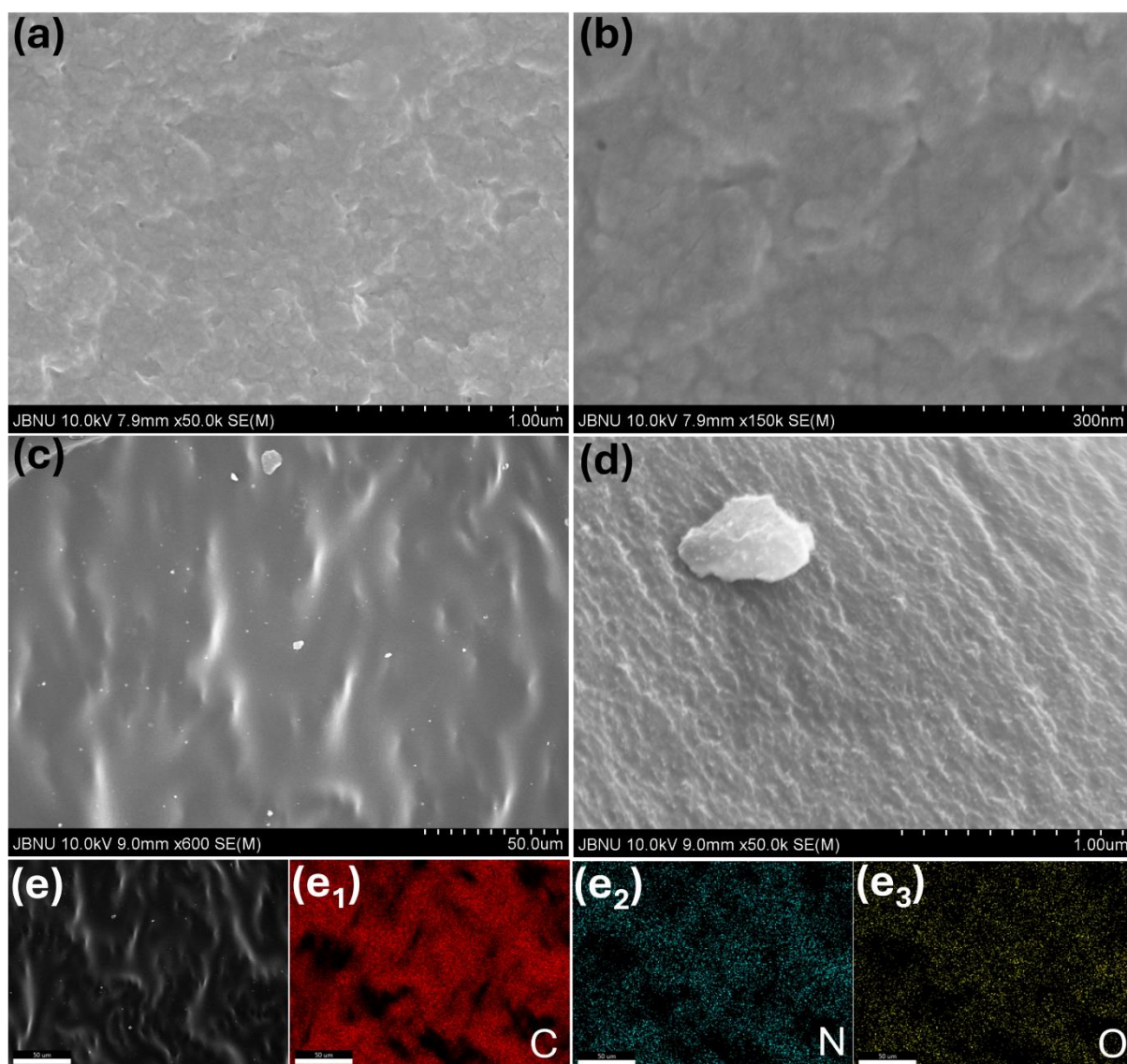


Figure S2: Fe-SEM image: (a, and b) PANs after the drying process, (c, and d) graphitized carbon (GC) of pure PANs after carbonization, and (e, e₁, e₂, and e₃) its elemental mapping.

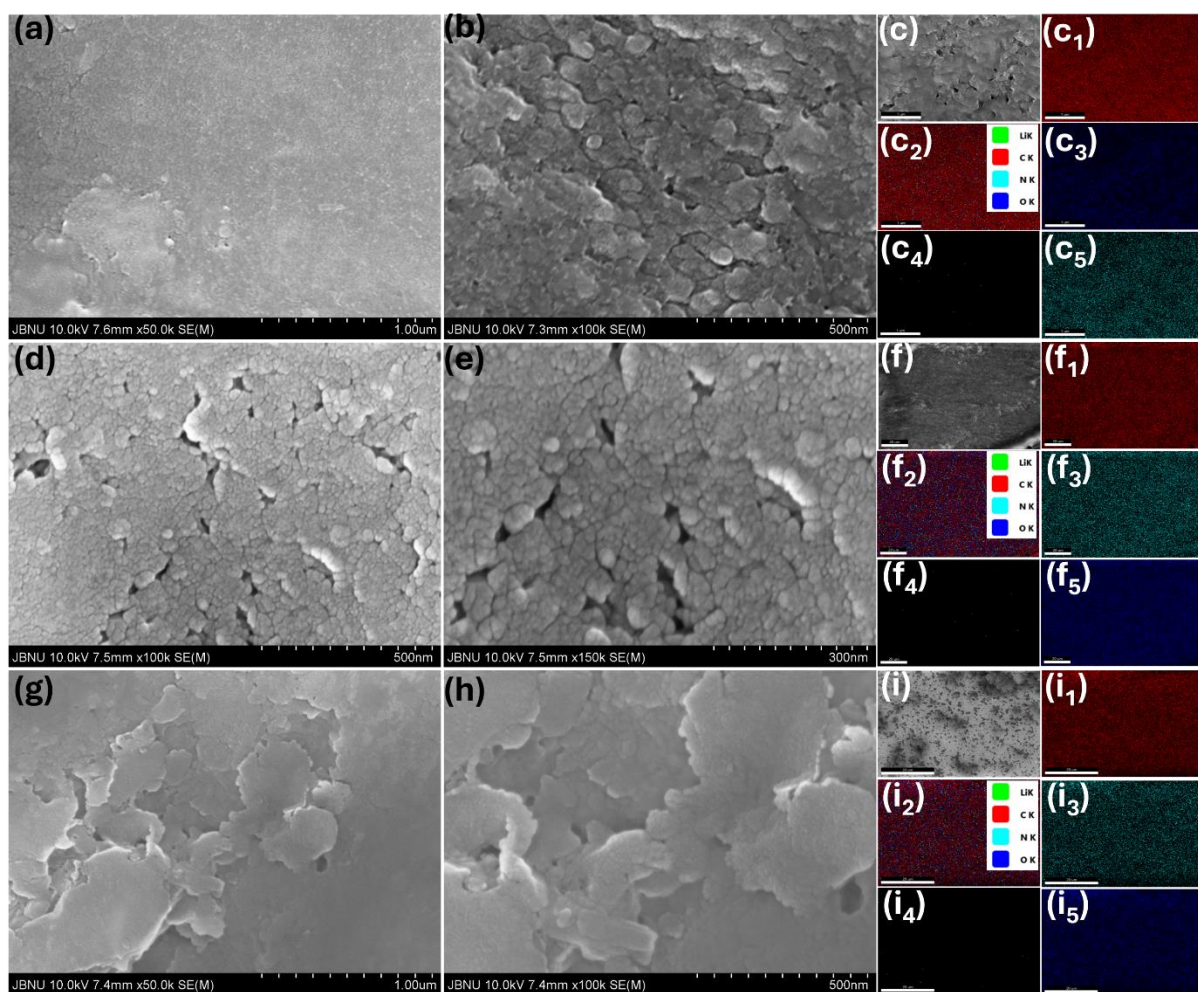


Figure S3: Morphological characterizations: (a, and b) FE-SEM images and (c, c₁, c₂, c₃, c₄, and c₅) elemental mapping of Li-PANs-5, (d, and e) FE-SEM images and (f, f₁, f₂, f₃, f₄, and f₅) elemental mapping of Li-PANs-10, (g, and h) FE-SEM images and (i, i₁, i₂, i₃, i₄, and i₅) elemental mapping of Li-PANs-15 after drying process.

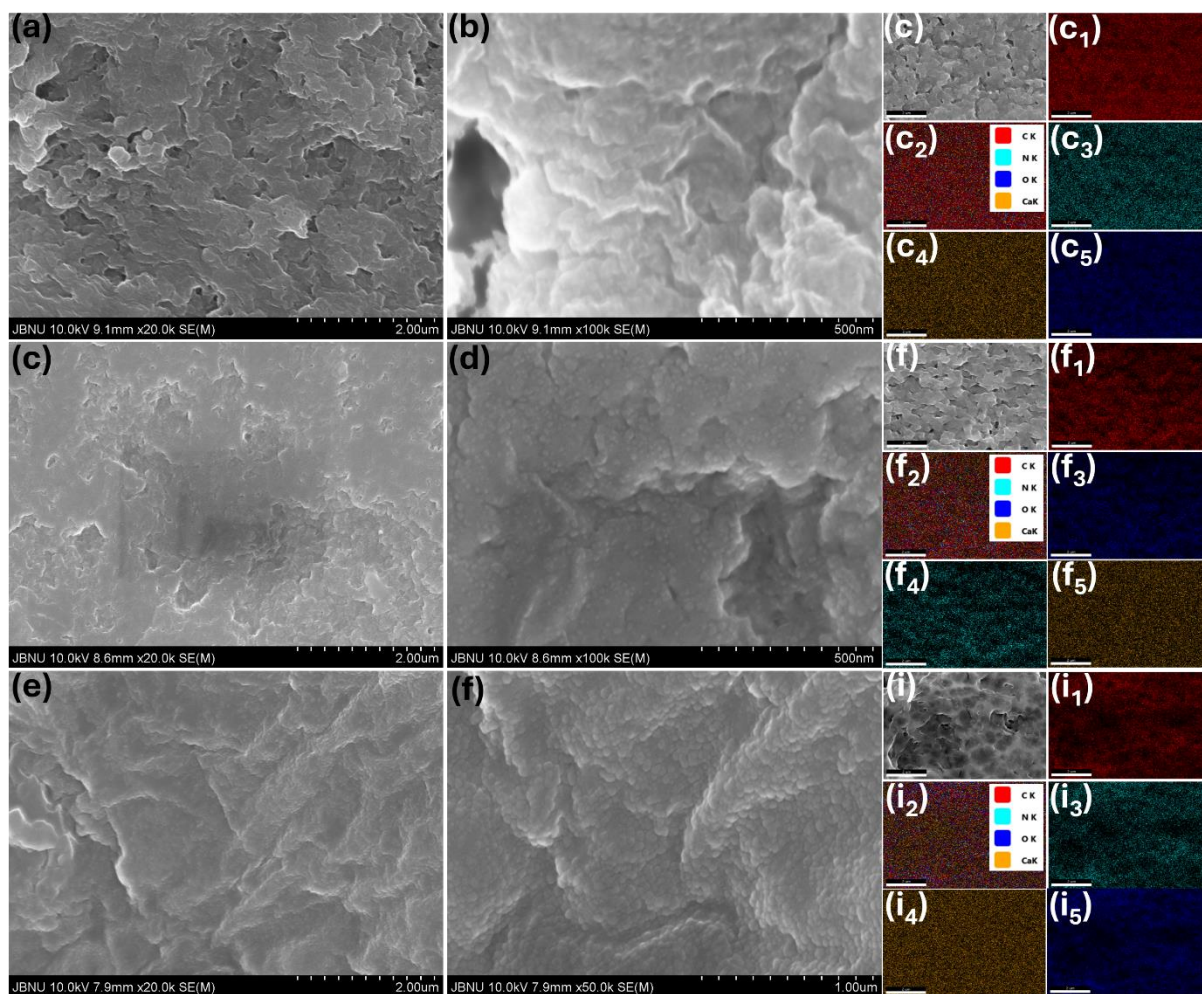


Figure S4: Morphological characterizations: (a, and b) FE-SEM images and (c, c₁, c₂, c₃, c₄, and c₅) elemental mapping of Ca-PANs-5, (d, and e) FE-SEM images and (f, f₁, f₂, f₃, f₄, and f₅) elemental mapping of Ca -PANs-10, (g, and h) FE-SEM images and (i, i₁, i₂, i₃, i₄, and i₅) elemental mapping of Ca -PANs-15 after drying process.

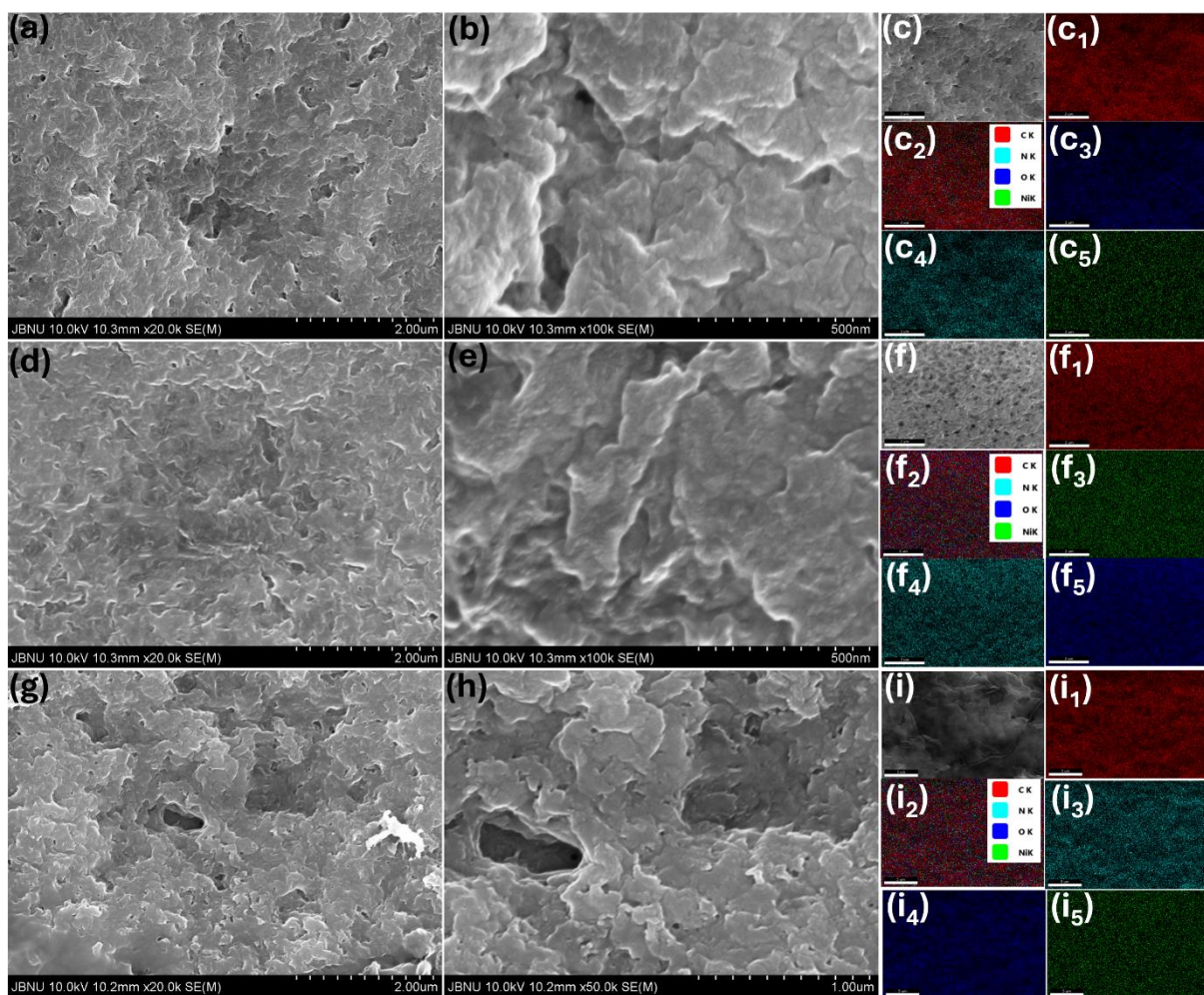


Figure S5: Morphological characterizations: (a, and b) FE-SEM images and (c, c₁, c₂, c₃, c₄, and c₅) elemental mapping of Ni-PANs-5, (d, and e) FE-SEM images and (f, f₁, f₂, f₃, f₄, and f₅) elemental mapping of Ni -PANs-10, (g, and h) FE-SEM images and (i, i₁, i₂, i₃, i₄, and i₅) elemental mapping of Ni -PANs-15 after drying process.

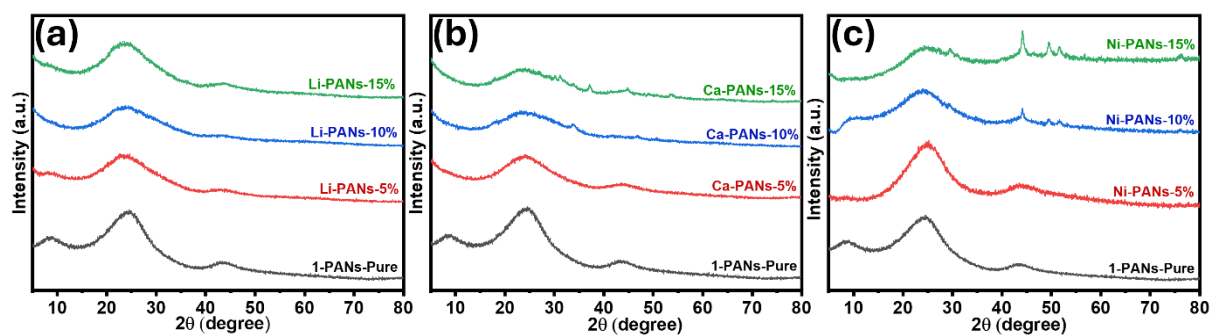


Figure S6: XRD analysis: (a) XRD pattern of Li-PANs-5, Li -PANs-10, and Li -PANs-15 (b) XRD pattern of Ca-PANs-5, Ca -PANs-10, and Ca-PANs-15, and (c) XRD pattern of Ni-PANs-5, Ni -PANs-10, and Ni -PANs-15 after drying process.

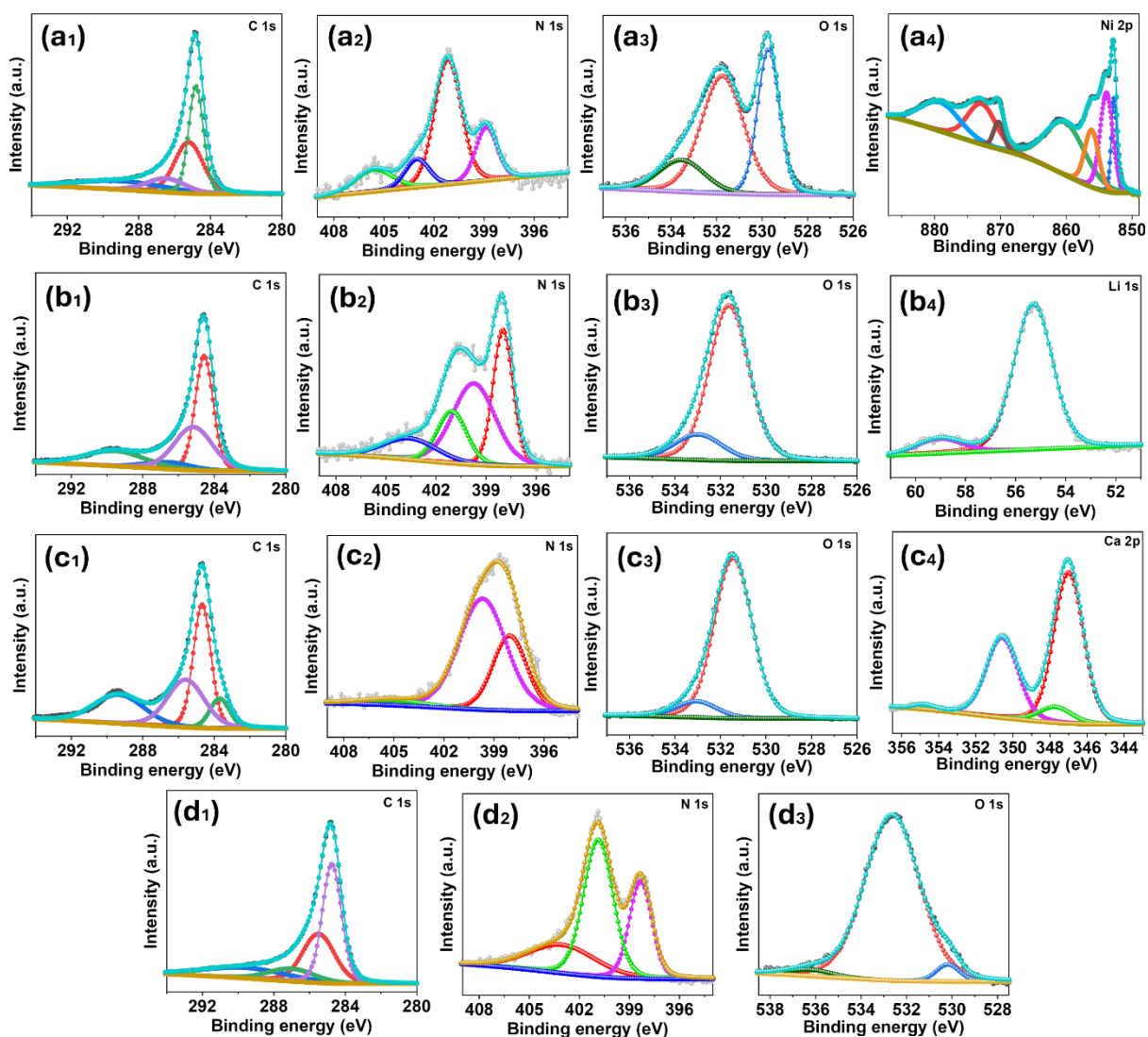


Figure S7: Deconvoluted XPS survey spectra of (a₁, a₂, a₃, and a₄) C1s, N1s, O1s, and Ni2p respectively of Ni-GC-15, (b₁, b₂, b₃, and b₄) C1s, N1s, O1s, and Li1s respectively of Li-GC-10, (c₁, c₂, c₃, and c₄) C1s, N1s, O1s, and Ca2p respectively of Ca-GC-5, (d₁, d₂, and d₃) C1s, N1s, and O1s respectively of Pristine GC.

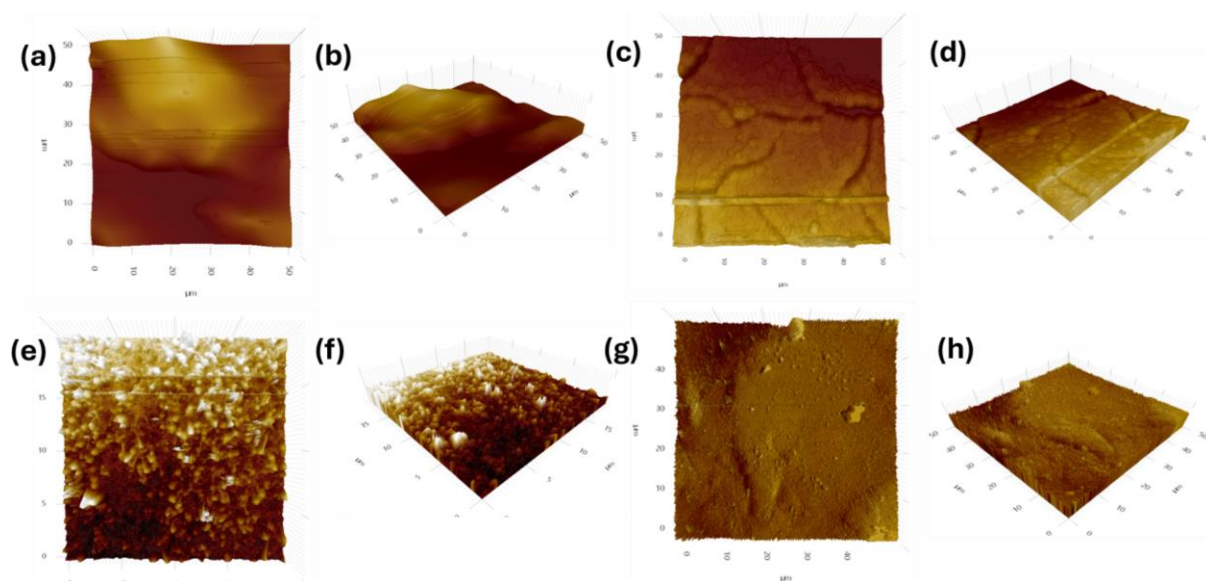


Figure S8: Top and tilted view AFM images of (a and b) Pristine GC, (c and d) Ca-GC-5, (e and f) Li-GC-10, and (g and h) Ni-GC-15.

Table S1: I_D/I_G ratio of earlier published similar materials.

S.N.	Sample Name	Graphitization Temperature	I _D /I _G ratio	References
1.	T-PAN	1000	0.9	1
2.	PAN nanofiber	2100	1.07	2
3.	PAN/CNT	1000	2.5	3
4.	HGBPC	700	0.906	4
5.	PAA-1300	1300	1.1	5
6.	5Ni@CNF	900	0.97	6
7.	CF-PIM-1	800	1.16	7
8	CNF-Co10	1000	0.9	8
9.	NHPC800	800	1.078	9

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