Electronic Supplementary Information for:

Fabrication of Tunable 3D Graphene Mesh Network with Enhanced Electrical and Thermal Properties for High-Rate Aluminum-Ion Battery Application

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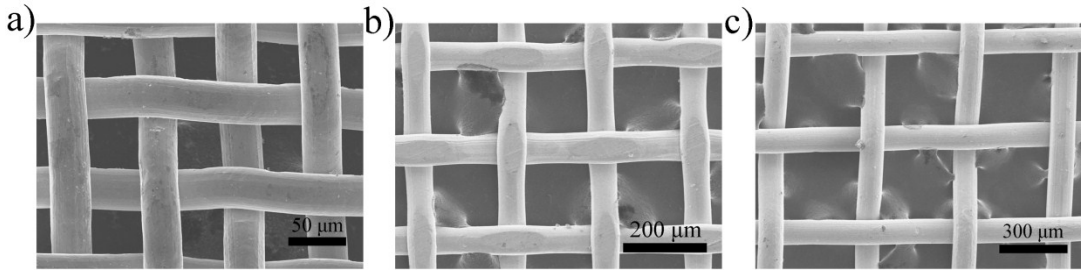

Figure S1. SEM images of the original nickel meshes in size of a) 400 meshes, **b)** 120 meshes， and **c)** 60 meshes.

As shown in figure S1a, the period and spacing of 400 mesh nickel mesh are about 73 μm and 35 μm, the period and spacing of the 120 mesh nickel mesh increase to 220 μm and 60 μm, respectively. The period and spacing of the 60 mesh nickel mesh are 410 μm and 110μm, respectively.

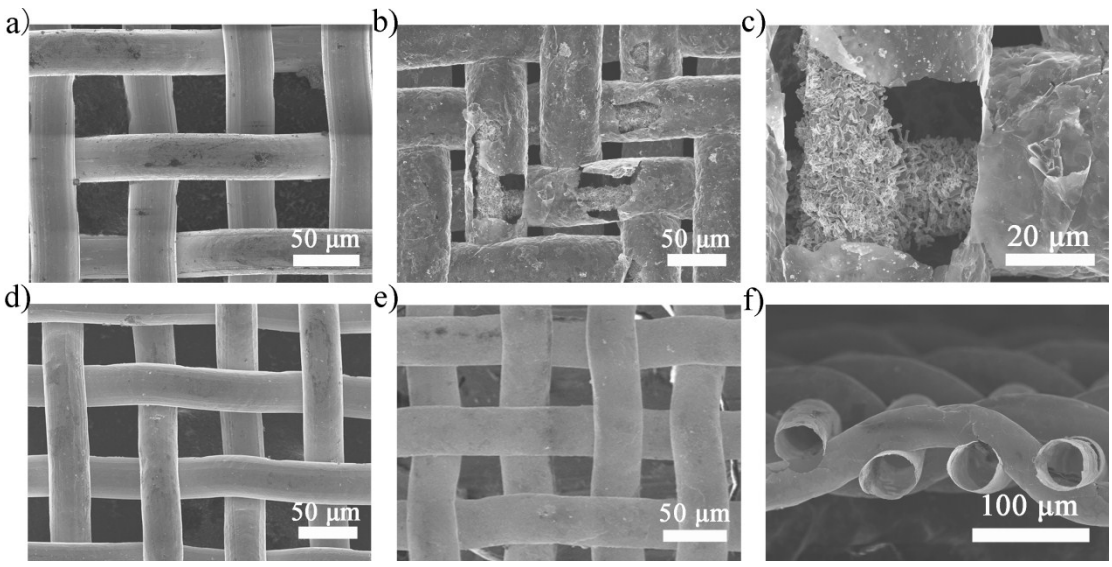

Figure S2. SEM images of a) the impure nickel mesh, b) the core-shell structure after removing Ni mesh, and c) enlarged higher-magnification SEM image of the core-shell structure; SEM images of d) the pure nickel mesh, e) resulted graphene network, and f) the corresponding cross-sectional SEM image.

If impure Ni mesh was used for the growth of 3D graphene mesh network, a core-shell structure would be finally obtained, as shown in Figure S2a and S2b. After etching Ni meshes, significant residues can be observed through the breakage of graphene shell in figure S2b and figure S2c, which is throughout the graphene tubes. This phenomenon also happens in other reports.[S1] It can be eliminated. As shown in Figure S2d, S2e and S2f, clear hollow network structure can be obtained without any residue inside if high purity Ni meshes were used.

Table 1. EDS result of the residue core.

Element	C	Cr	Fe	Ni	Mo
wt%	24.3	46.41	23.28	4.18	1.83

EDS measurement was conducted to investigate the elemental composition of the residue core in the graphene tubes, which indicates that there are many kinds of metallic element residual in the core beside carbon, including Cr, Fe, Ni and Mo. It can be concluded that carbon and metal elements diffuse together with formation of a complex composite which is resistance to corrosion during etching process.

Reference:

S1: X. Li, X. Zang, Z. Li, X. Li, P. Li, P. Sun, X. Lee, R. Zhang, Z. Huang, K. Wang, D. Wu, F. Kang and H. Zhu, *Adv. Funct. Mater.*, 2013, **23**, 4862-4869.