All-Electrochemical nanofabrication of stacked ternary metal sulfide/graphene electrodes for high performance alkaline batteries

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New approaches are required to create electrode materials with hierarchical and tunable structures to maximize both ion and charge transport for energy storage. These aspects are critical to get practical electrodes with significant mass loading and adequate performance. [1,2]
Here, we demonstrate a versatile two-step approach combining electrophoretic deposition (EPD) and cathodic electrodeposition (CED) to fabricate multilayer hierarchical electrodes made of reduced graphene oxide (rGO) and mixed transition metal sulfides (NiCoMnSx or NCMS) (see Figure 1). The interleaved structure obtained provides an ideal porous network and a continuous conductive path for a facile transport of ions and electrons.[3]
A full Rechargeable Alkaline Battery (RAB) cell with an anthraquinone-based conjugated microporous polymer (IEP-11) as anode and our optimized NCMS-G2 multilayer composite as cathode was assembled with a maximum energy density of 97.2 Wh·kg−1 and a maximum power density of 3.1 W·kg−1, calculated on the total mass of active materials, and outstanding cycling stability (retention 72% after 7000 charge/discharge cycles at 10 A·g−1). When the total electrode mass of the cell is considered, we achieve an unprecedented gravimetric energy density of 68.5 Wh·kg−1, seven-fold higher than that of typical commercial supercapacitors, higher than that of Ni/Cd or Lead-Acid Batteries and similar to Ni-MH Batteries. Our approach can be used to assemble arbitrary, multilayer composite structures on complex electrode shapes.

REFERENCES

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FIGURES

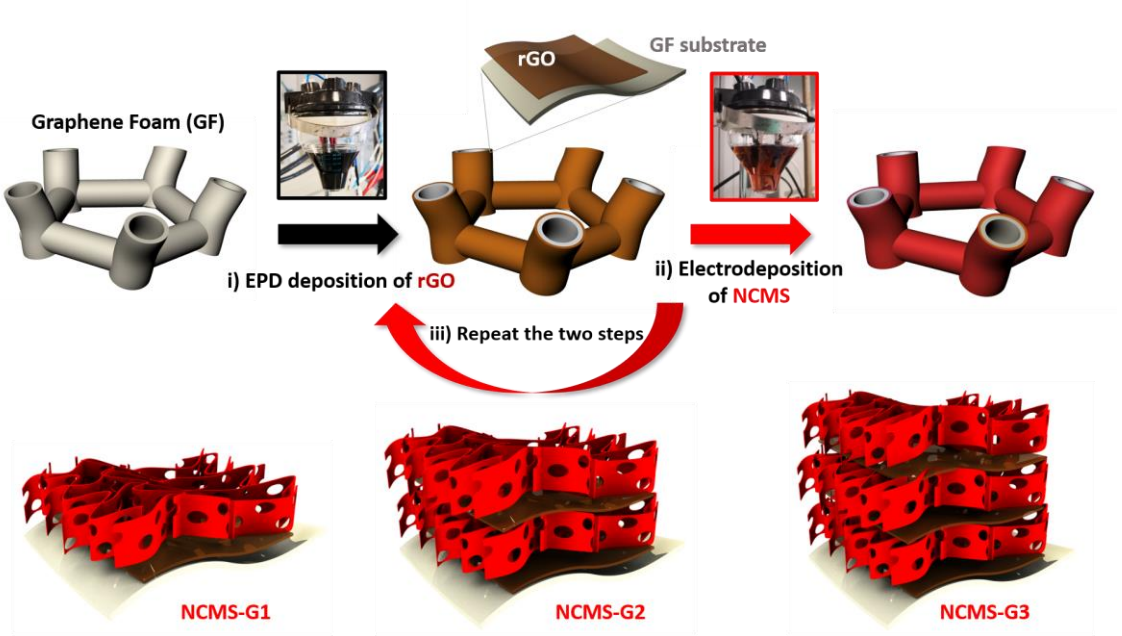

Figure 1: Schematic illustration of the preparation process for multilayer rGO/NCMS graphitic foam architectures.