High-Performance Silicon Anodes via Functionalized Graphene (UCMG) Coating and Graphene Hybrid Polymeric Binders (GHPB)

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Abstract (Century Gothic 11)
This study highlights the electrochemical benefits of functionalized graphene (UCMG) coating technology in enhancing silicon-based anode materials for next-generation lithium-ion batteries [1]. By precisely controlling functional groups (~15 at. %) and maintaining a high positive zeta potential (+40~60 mV), UCMG enables a "binder-free" self-assembly coating on silicon anode surfaces, creating a robust wrapping structure that suppresses secondary reactions and mitigates volume expansion issues [2]. Furthermore, the applying of Graphene Hybrid Polymeric Binders (GHPB) establishes a dense graphene network at the interface between active materials and current collectors, significantly improving electrical conductivity and adhesion [3]. Experimental cases demonstrate that GHPB application increases the initial coulombic efficiency from and enhances discharge capacity compared to conventional PAA binders. Additionally, electrochemical impedance spectroscopy analysis shows a substantial reduction in internal resistance, validating GHPB as a critical solution for high-capacity and long-lifespan "Graphene Network Batteries". This work was supported by R&D Program funded by the Ministry of Trade, Industry and Energy (MOTIE) and , Ministry of SMEs and Startups (MSS) Republic of Korea (Project No. RS-2024-00431451, RS-2024-00417175, RS-2024-00469936, RS-2023-00303772).

References

[1] Kim et al., Nature Communications, 12 (2021) 6089
[2] S. Chae et al., Nature Energy, 5 (2020) 195-204
[3] Z. Zhang et al., Advanced Functional Materials, 31 (2021) 2106774

Figures

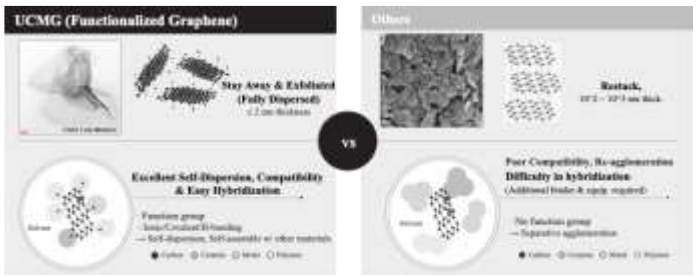

Figure 1: Differentiating advantages of UCMG compared to conventional graphene

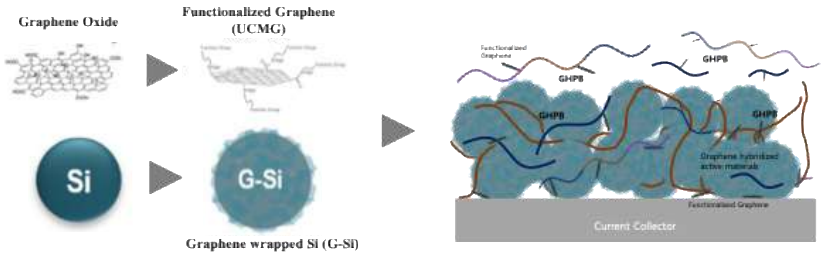

Figure 2: Schematic diagram of UCMG & GHPB applied anode system