Applied to Secondary Battery with Structurally and Chemically Defective Crumpled Graphene

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Structurally and chemically defective activated-crumbled graphene (A-CG) is employed to achieve unique synergy of large reversible potassium (K) and sodium (Na) ion storage capacity with fast charging and extended cyclability. A-CG synthesis consists of low temperature spraying of graphene oxide slurry, followed by partial reduction annealing and air activation. For K storage, the reversible capacities are 340 mAh/g at 0.04 A/g and 210 mAh/g at 2 A/g. For Na storage, the reversible capacities are 280 mAh/g at 0.04 A/g and 151 mAh/g at 2 A/g. A-CG shows a stable intermediate rate (0.5 Ag−1) cycling with both K and Na, with minimal fade after 2800 and 8000 cycles. These are among the most favorable capacity—rate capability—cyclability combinations recorded for potassium-ion battery and sodiumion-battery carbons. Electroanalytical studies and density functional theory(DFT) reveal that enhanced electrochemical performance originates from ion adsorption at various defects. Moreover, DFT highlights enhanced thermodynamic stability of A-CG with adsorbed K versus with adsorbed Na, explaining the unexpected higher reversible capacity with the former.