Real-time imaging of Na+ reversible intercalation in “Janus” graphene stacks for battery applications

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Sodium, in contrast to other metals, cannot intercalate in graphite, and this hinders the use of this cheap, abundant element in rechargeable batteries. Here, we report a nanometric graphite-like anode for sodium ions storage, formed by stacked graphene sheets functionalized only on one side, termed Janus graphene. The asymmetric functionalization allows reversible intercalation of Na^+, as we monitored by *operando* Raman spectro-electrochemistry and visualized by imaging ellipsometry, both in real time. Our Janus graphene has only one chemical functional group, uniform pore size, controllable functionalization density, very few edges; it can store Na^+ differently from both graphite and stacked graphene. Density Functional Theory (DFT) calculations demonstrate that Na^+ preferably rests close to the $-NH_2$ group forming a synergic ionic bond to graphene, making the interaction process energetically favourable. We estimate a sodium storage up to $C_{6.9}Na$, comparable to what currently achieved in standard lithium ion batteries. Our approach provides a new concept to design carbon-based materials as anode for the application of sodium ion battery.

FIGURES

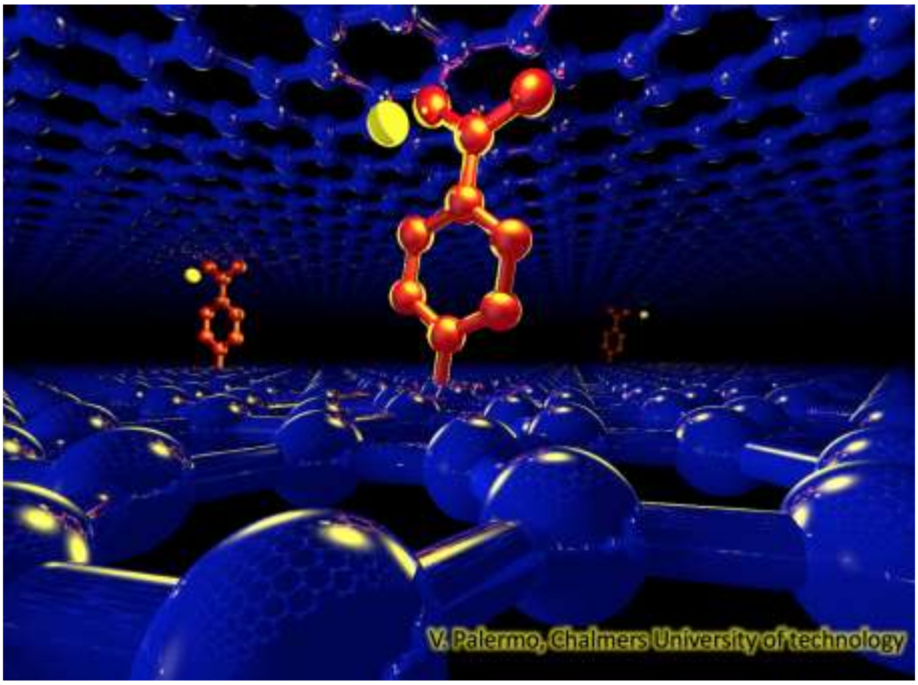

Figure 1: Cartoon showing Na+ ions intercalated in between graphene sheets with aminobenzene spacers.