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Lithium-Intercalated Few Layer Graphene: Approaching the Limits of Transparency and Conductivity in Graphene-based Materials

WENZHONG BAO, JIAYU WAN, XIAOGANG HAN, XINGHAN CAI, HONGLI ZHU, DOHUN KIM, YUNLU XU, JEREMY MUNDAY, H. DENNIS DREW, MICHAEL FUHRER, LIANGBING HU, University of Maryland College Park, UNIVERSITY OF MARYLAND COLLEGE PARK COLLABORATION — We measure simultaneous *in situ* optical transmittance spectra and electrical transport properties of few-layer graphene (FLG) nanostructures upon electrochemical lithiation/delithiation. Reversible Li-intercalation stages and a two-phase boundary are observed optically. Due to the unusual electronic structure of FLG, upon intercalation we observe a simultaneous increase of both optical transmittance and DC conductivity, strikingly different from other materials. Transmission as high as 91.7% for sheet resistance of 3.0 Ω/square is achieved for 19 layer LiC_6, corresponding to a figure of merit (FOM) $\sigma_{dc}/\sigma_{opt} = 1400$, five times higher than any previously demonstrated for a continuous transparent electrode. The unconventional modification of FLG optoelectronic properties is explained by the suppression of interband optical transitions and a small intraband Drude conductivity near the interband edge. Our techniques can enable investigation of other aspects of intercalation in nanostructures, for example intercalation dynamics and solid-electrolyte interface formation.

Wenzhong Bao
University of Maryland College Park

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