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Highly Concentrated and Conductive Reduced Graphene Oxide Nanosheets by Monovalent Cation-π Interaction: Toward Printed Electronics

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We introduce a novel route to preparing highly concentrated and conductive reduced graphene oxide (RGO) in various solvents by monovalent cation–π interaction. Previously, the hydrophobic properties of high-quality RGO containing few defects and oxygen moieties have precluded the formation of stable dispersion in various solvents. Cation–π interaction between monovalent cations, such as Na+ or K+, and six-membered sp2 carbons on graphene were achieved by simple aging process of graphene oxide (GO) nanosheets dispersed in NaOH or KOH solution. The noncovalent binding forces introduced by the cation–π interactions were evident from the chemical shift of the sp2 peak in the solid 13C NMR spectra. Raman spectra and the I-V characteristics also demonstrated the interactions in terms of the presence of n-type doping effect due to the adsorption of cations with high electron mobility (39 cm2/Vs). The RGO film prepared without a post-annealing process displayed superior electrical conductivity of 97,500 S/m at a thickness of 1.7 m. Moreover, mass production of GO paste with a concentration as high as 20 g/L was achieved by accelerating the cation–π interactions with densification process. Our strategy can facilitate the development of large scalable production methods for preparing printed electronics made from high-quality RGO nanosheets.