A General Method to Disperse Solid Carbon Materials without Passivating Agents or Surface Modifications

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Graphite was treated with concentrated ammonium hydroxide for some days at room temperature, washed and exfoliated in water [1]. The resultant aqueous dispersion is metastable and has lyophobic nature. This graphite dispersion has concentration next to 25 mg L^{-1} and particles with lengths and widths of hundreds of nanometers and mean thickness between 10 and 40 nm typical of exfoliated graphite. The aqueous dispersion does not have any passivating agents, but remains dispersed for at least 6 months due to the mean zeta potential of -45 mV that provides electrostatic repulsion between dispersed particles. No functional groups or nitrogen doping were detected on graphite after the treatment with ammonium hydroxide, and the treated material was washed twice before sonication to remove most hydroxide, therefore neither functional groups, nitrogen atoms, nor hydroxide excess are responsible for the experimental zeta potential [1]. The contact of ammonia with pristine graphite promotes redox reactions and ammonia transfers electrons to graphite, which raises the Fermi level of the solid material and generates the negative zeta potential, consequently, such electron transfer is responsible for the colloidal stability. We also have extended this method to other carbon-based solids (sp^2). A carbon material that has gained attention is activated carbon (AC), not only because of the adsorptive properties highly explored in many applications, but because it is an edible conductor [2] and can be used to prepare edible electronic devices. AC was treated with ammonium hydroxide, washed and sonicated in water, resulting in an aqueous AC dispersion with concentration of about 75 mg L^{-1}, dispersed aggregates with sizes between about 60 and 500 nm, mean size of 220 nm, and mean zeta potential of -40 mV. No surface modification was detected, which is consistent with the hydrophobic behaviour and previous results for graphite. This method proved to be efficient for different carbon materials and has provided colloidal stability for long periods without passivating agents or functional groups, highlighting its great potential in the context of greener carbon-based dispersions.

References

[1] J. P. V. Damasceno and L. T. Kubota, Angewandte Chemie 61 (2022) e202214995.
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