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Fabrication of Fe-Cu Bimetallic Nanoparticles on Graphene for the Removal of Trichloronitromethane in Water

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Extended Abstract

Halonitromethanes (HNMs), as an emerging class of disinfection by-products containing nitrogen (N-DBPs) in drinking water, have possessed a hazard to public health [1]. Halonitromethanes (HNMs) had frequently been detected in drinking water, sewage and swimming pool water [2-3]. Previous studies suggested that bimetallic particles with iron as the principal metal have been effective in degrading various organic and inorganic compounds [4]. The aim of this study is to prepare graphene supported Fe-Cu bimetallic nanocomposites (G-Fe-Cu) and evaluate the effects of G-Fe-Cu nanocomposites on degradation of trichloronitromethane (TCNM) in water.

Based on the data of XRD, TEM, XPS, Raman and BET, zero-valent Fe/Cu has been successfully combined into bimetal nanocomposites supported on graphene via facile carbonization and calcinations of glucose and ferric chloride mixtures. When the mass ratios of C/Fe/Cu was 50:10:1, the TEM images of G-Fe-Cu showed that the Fe^0/Cu^0 nanoparticles were well dispersed on the surface of graphite without aggregation and the particles size ranged from 5-30 nm. The images of XRD, and XPS revealed the individual nanoparticles were composed by the Fe^0/Cu^0 crystalline state and the Fe^0/Cu^0 nanoparticles of the G-Fe-Cu composite were assumed to be intercalated in graphene layers. Batch experimental results indicated that the as-prepared G-Fe-Cu could effectively remove TCNM in water. Morn than 99.7% of initial TCNM could be adsorbed and degraded under 10 mg/L G-Fe-Cu dosage (Fe^0) within 60 min. The kinetic studies revealed that the removal of TCNM in water by G-Fe-Cu followed a pseudo first order rate ($R^2 > 0.96$). The dissolved oxygen and residual chlorine of the solution could affect the removal efficiency of TCNM. The degradation efficiency of TCNM decreased with increasing pH from 5.5-8.5. The image of XRD of the used nanocomposites showed that Fe_3O_4 and Fe_2O_3 were the corrosion products of Fe^0 nanocomposites after reaction, covered on the surface eventually leading the decrease of the reduction ability. In the process of reaction, the nano zero-valent iron corroded to Fe (II) and released into the solution. Fe (II) were absorbed and transformed to a mixture of iron oxides in the graphene material shape, however, the used G-Fe-Cu nanocomposites might be regenerated by calcinations in an Ar atmosphere.

In conclusion, the synthesized G-Fe-Cu nanocomposites could be a powerful material to remove HNMs from drinking water.

Keywords: Trichloronitromethane; removal; zero-valent iron; bimetallic nanocomposites; graphene

References

[1] M. J. Plewa, E. D. Wagner, P. Jazwierska, S. D. Richardson, P. H. Chen and A. B. Mckague, "Halonitromethane drinking water disinfection byproducts: Chemical characterization and mammalian cell cytotoxicity and genotoxicity," *Environ. Sci. Technol.*, vol. 38, pp. 62-68, 2004.

[2] J. Hu, H. Song, J. W. Addison and T. Karanfil, "Halonitromethane formation potentials in drinking waters," *Water Res*., vol. 44, pp. 105-14, 2010.

[3] S. W. Krasner, P. Westerhoff, B. Y. Chen, B. E. Rittmann and G. Amy, "Occurrence of disinfection byproducts in United States wastewater treatment plant effluents," *Environ. Sci. Technol*., vol. 43, no. 21, pp. 8320-8325, 2009.

[4] Ghauch and A. Tuqan, "Reductive destruction and decontamination of aqueous solutions of chlorinated antimicrobial agent using bimetallic systems," *J. Hazard. Mater*., vol. 164, pp. 665-674, 2009.