In situ Solution Plasma Synthesis of Amine-Terminated Silane-Modified Carbon Nanoparticles for Efficient Removal of Heavy Metal Ions

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In recent years, the presence of heavy metal ions in groundwater and seawater systems has been attracted much attention due to their adverse effects on public health and ecological systems. Therefore, it is necessary to develop various efficient materials for removal of heavy metal ions contaminant. Carbon material is the most extensively used in this purpose based on its inexpensive, high specific surface area, minimal costs, fast water transport, as well as its reusability. Nowadays, the researches focused on the development of carbon adsorbents with enhanced adsorption capacity. According to the previous work, it is well−known that the creation of functional group on carbon materials such as amine groups could be used as active site which expected to enhance the removal of metal ions from aqueous solution. However, these conventional modification methods lead to a complicated solution, high cost, high toxic reagent as well as long time. Solution plasma process is one of the promising techniques which has been applied for the synthesis of carbonaceous materials. This process offers several advantages, for example, simple experimental system, inexpensiveness, short-time operation, and processing at room temperature and atmospheric pressure.

In this study, amine-modified on carbon nanoparticles was conducted by facile synthesis via a solution plasma process using the organic mixture of carbon precursor and Amine-terminated silane (ATS) and utilized for heavy metal ions removal application. The characteristic of the adsorbent could be adjusted conveniently by the concentration of ATS. The 3% v/v ATS modified-carbon was effectively promoted in the metal ions removal application. It was observed that the adsorption capacity was ranked in order of 61.79, 57.57, 45.84, and 40.86 $mg \cdot g^{-1}$ for Cu^{2+}, Pb^{2+}, Zn^{2+}, and Cd^{2+}, respectively. Further investigation revealed that the pseudo-second-order kinetic and the Langmuir adsorption isotherm were provided an accurate description of the equilibrium time and maximum metal ions adsorption on the adsorbent, respectively. Moreover, the heavy metal ions removal efficiency of prepared sample was found to be better than that of amine-modified on various types of conventional adsorbents.