

Arsenic Removal with Phosphorene and Graphene

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ABSTRACT

This first attempt study explored characteristics of prepared phosphorene materials for promising As(III) treatment. The past year has witnessed the fast growth of investigations on monolayer and few-layer black phosphorous, turned as 'phosphorene.' Same as graphene, single-layer phosphorene is flexible and can be mechanically exfoliated. In this study, the phosphorene catalysts were prepared by exfoliation method. Moreover, four kinds of arsenic concentration, including 0.5, 1, 2 and 4 ppm were tested. The morphology and elastic strain of the composites were analyzed by transmission electron microscopy, atomic force microscopy and UV-Visible spectrum. Compared to phosphorene materials, the most appropriate rate of As(III) adsorption rate at 0.0329min^{-1} was achieved. The apparent values for Freundlich adsorption capacities were 4.67 mg g^{-1} for As(III) at pH7.

In this study, the phosphorene catalysts were prepared by exfoliation method. 200 μL As^{3+} standard solution was diluted to 500mL and supersonicated for 10 minutes as challenge pollutant. The solution was poured into 250mL storage bottle. Then, the pH value was measured and adjusted to pH7 before 2 mL mixed solution was extracted into test tube as Co. In addition, phosphorene was uptaken for 40 μL and poured into storage bottle. The contact time was set in 1, 2, 3, 4, 5, 10, 15, 20 and 25minutes. The concentration of extracted solution was analyzed by ICP-AES (Angilent Inc.).

In order to assess the performance with 40 μL of phosphorene for removing As(III). The efficiency could reach 60% when adsorption time reached 20minutes under 2ppm. Others, the adsorption efficiency reached 57% under 2ppm, as shown in Fig 1. Besides, the reaction rate was 0.0223min^{-1} under 1ppm with 0.04 g L^{-1} phosphorene. In contrast, the reaction rate was 0.00189 min^{-1} under 2ppm, as shown in Table 1. This results showed the reaction rate of phosphorene is more higher than that of graphene under 0.5ppm of As(III).

25°C, pH7,40mL

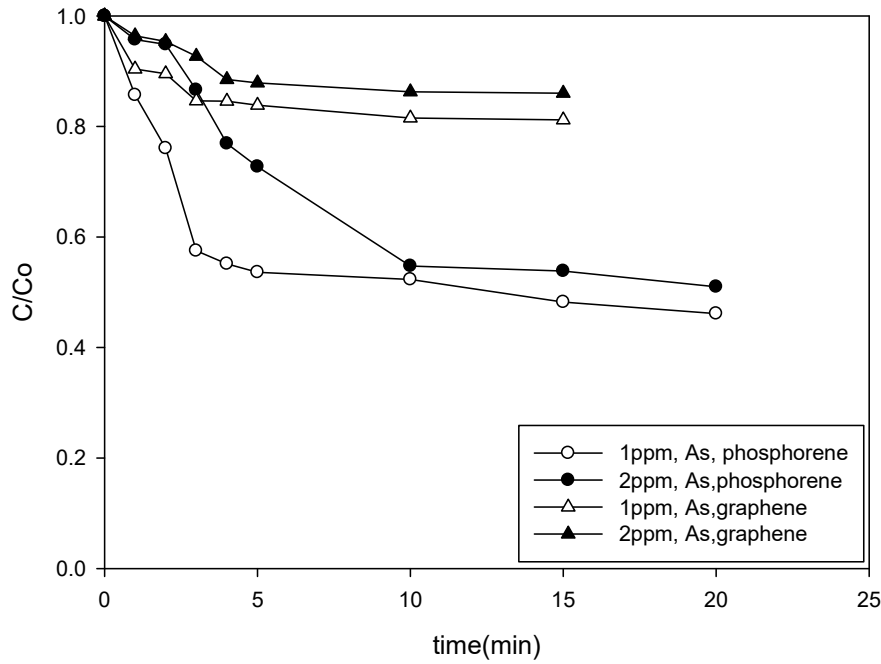


Figure 1. Effect of concentration on As(III) adsorption with graphene and phosphorene.

Table 1. Comparison of arsenic adsorption reaction rate with various adsorbents.

	phosphorene	graphene
0.5ppm	0.0329 min ⁻¹	0.0146 min ⁻¹
1.0 ppm	0.0223 min ⁻¹	0.0170 min ⁻¹
2.0 ppm	0.00189 min ⁻¹	0.00442 min ⁻¹
4.0 ppm	0.00161 min ⁻¹	0.00359 min ⁻¹

In order to assess the effect of concentration on adsorption efficiency, the concentration was controlled at 0.5, 1.0, 2.0 and 4.0 ppm with pH7 and phosphorene of 0.04 gL⁻¹. The adsorption capacity of 0.5, 1.0, 2.0 and 4.0 ppm was 1.26, 1.71, 1.83 and 2.03 mg g⁻¹ for As, respectively. The efficiency is decreased with increasing concentration since the reaction activity sites of materials are easy to be occupied with larger concentration, as shown in Fig2.

phosphorene, pH7, 40mL

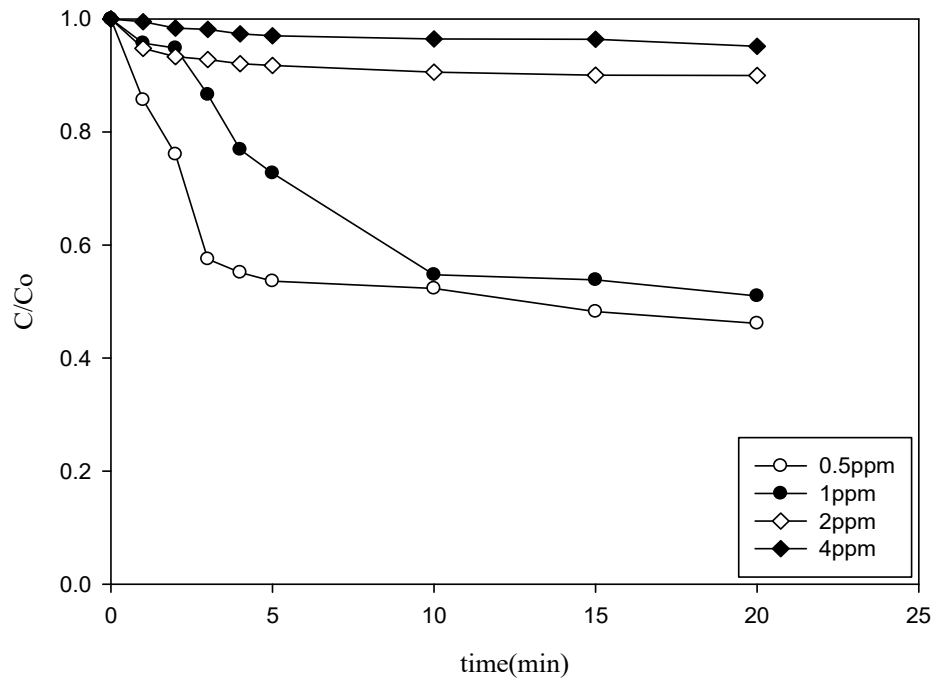


Figure 2. Effect of concentration on As(III) adsorption with phosphorene.