Abstract

Several two-dimensional (2D) nanomaterials are being actively explored as potential candidates for capturing CO_2 owing to their high surface area, superior thermal stability, extremely high density of catalytically active sites, and tunable surface chemistry. These properties are enabling a newer paradigm in CO_2 capturing technologies. Our research group at IIT Gandhinagar has discovered a new family of 2D materials – transition metal diboride nanosheets (TMDB's). Recently, we have also discovered a scalable recipe to exfoliate TiB_2 nanosheets. These nanosheets are special as they contain additional oxy-functional groups such as TiO_2, BO_3^{3-}, and BO_4^-. These functional groups are known to be useful in either capturing CO_2 gas molecules or converting them to hydrocarbons. These studies made us curious to examine the CO_2 capturing capacity of our TiB_2-based nanosheets. On the other hand, calcium oxide-based materials are widely used as regenerable CO_2 adsorbents at high temperatures because of their high CO_2 reactivity, easy recyclability, and low cost. However, the adsorption capacity of these materials drastically decreases with multiple carbonation-calcination (decarbonation) cycles due to particle agglomeration. One way to deal with such a challenge is by doping it with thermally stable material. Therefore, we were also interested in investigating the influence of TiB_2-based nanosheets on the capturing capacity of CaO-based adsorbents in multicycles. Following these studies, our aim was boiled down to two approaches: Examining CO_2 capturing capacity of (i) nanosheets, and of (ii) CaO with nanosheets as nano-additive. After some investigations, we observed that although the nanosheets were not found to be very efficient in capturing CO_2, promising results were obtained by using them as a nano-additive in calcium oxide-based adsorbents. We observed that adding just 1% of nanosheets can enhance the capturing capacity of up to 25%. These observations indicate the possibility of CO_2 capturing capacity enhancement for CaO-based adsorbents using TiB_2 nanosheets.

Keywords: nanomaterials, CO_2 capture, TiB_2 nanosheets, CO_2 capturing capacity, calcium oxide-based adsorbents