New 2D boron materials: hydrogen boride and boron monosulfide nanosheets

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As new 2D metal-free materials, we have experimentally synthesized hydrogen boride (HB) sheets [1] and boron monosulfide (BS) sheets [2]. The BS sheets are crystalline semiconductor and its bandgap was found to be tuned to a desired value by controlling the number of stacked 2D BS nanosheet [2]. Moreover, the stacked BS sheets, rhombohedral BS (r-BS), is found to be as a p-type semiconductor [3] and have a great electrocatalytic property for oxygen evolution reaction in alkaline solution [4,5]. HB sheets are composed of boron and hydrogen at a 1:1 stoichiometric ratio, which can be formed by an ion-exchange reaction between protons and magnesium cations in magnesium diboride with exfoliation [2]. In the HB sheets, boron atoms form a hexagonal 2D network, in which hydrogen atoms are bound to boron by three-center-two-electron bonds (B–H–B) and two-center-two-electron bonds (B–H) [6]. Experimental studies have clarified that HB sheets exhibit solid acid catalytic activity [7], metal ion reducibility [8, 9], semimetal electronic properties [10], gas-sensor applicability [5], stability against water [11], CO_2 adsorption/conversion property including C-C coupling [12], and a light-responsive hydrogen release function [13,14]. In the presentation, recent progress of BS and HB sheets will be introduced.

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