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Porous boron nitride (BN) synthesis and shaping

The proposed technologies include methods to: (i) tune the porosity of boron nitride (BN) and (ii) shape porous BN into densified ready-to-use macrostructures.

Proposed use

Porous BN represents a new addition to the porous materials family. Its potential applications include for instance: heterogeneous catalysis (e.g. oxidative dehydrogenation of alkanes), gas and liquid separations (e.g. water cleaning, hydrocarbons removals) and gas storage (e.g. H_2 and CH_4 storage, including onboard gas storage applications). In all these applications, the porosity of the material impacts its performance and therefore controlling its porosity – quantity and distribution – is needed. In addition, all applications require the materials to be in a usable macroshape instead of a powder. Here, we propose methods that allow one to control the pore size distribution of porous BN and to produce porous BN in a high density and mechanically robust macroshape.

Problem addressed

Due to the high synthesis temperature and the relatively high stability of porous BN, it is challenging to tune the porosity of the material. Existing methods usually result in low porosity and/or extended processing time/number of steps, which are not ideal for industrial scale applications.

In addition, identifying a way to shape and densify porous BN into macrostructures without compromising the porosity of material remains difficult. Current lab-scale approaches focus on synthesizing either BN aerogel or sintered porous BN. Yet, these approaches either to good mechanical robustness at the expense of porosity or vice versa.

Technology overview

To tune the porosity of BN, the invention uses a simple method that employs multiple nitrogen-containing precursors with distinct thermal decomposition profiles. By selecting such precursors, porogens are generated over a wide range of temperatures, thereby leading to a tunable microporosity, total porosity and surface area.

Furthermore, by applying a N-containing mechanically stable polymer with a suitable amount of foaming agent, a BN macrostructure with high mechanical stability and porosity can be obtained. The resulting BN possess a high bulk density and surface area, leading to the highest volumetric surface area among BN samples published to date.

Benefits

- Production of porous BN with tunable porosity and surface area
- Production of BN macrostructures ready to use for practical applications
- Production of BN macrostructure with high bulk density, porosity and surface area
- BN macrostructure exhibits the highest volumetric surface area among other porous BN samples reported, making it a candidate for onboard gas storage
- The methods rely on following common wet synthesis steps and readily available chemicals, which facilitates scale-up
- The methods include detailed information on the formation mechanism of BN, which can inform large scale production

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Intellectual property information

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POROUS BORON NITRIDE: European Application (Number: 18714825.9), US Application (Number: 16/494132) and Chinese Application (Number: 201880028699.9). Imperial reference number 8190.

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