# Boron Nanoparticle - The Least Studied Nanoparticle

Materials Chemistry Scientific Research Review Article

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## Abstract

*Boron is the least understood metalloid of group III in the periodic table that is present in small quantity in the meteoroids however uncombined boron also exists naturally on earth. Besides being an essential micronutrient in human diet, Boron nanoparticles possess high thermal and electrical resistance which makes it suitable to be used in thermoelectric reactors, nuclear reactors and thermal control devices.*

**Keywords:** Metalloid; Catalysts; Amorphous; Vapor phase; Electrolytic condensation; Mechanochemical

## Introduction

The chemical element boron is an essential trace element that is required in the living metabolism of humans, animals and plants [1].However boron is also known to be the least understood element in the periodic table [2].On the other hand boron nanoparticles are well known for their highest gravimetric heat of combustion [3] and corrosion resistance property [4].Boron nanoparticle is a blackish/brownish powder which is mainly used for its thermal resistance and corrosion inhibition properties in applications where high thermal/ electrical resistance is required such as in antifreeze, hydraulic systems and metal coatings [5,6].In addition it is also employed in photography, fuel cells, tanning and electrolytic condensation[7,8].Boron nanoparticles lie within the range of 20 to 100 nm with a surface area from 7 - 50 m2/g [9].

## Types of Boron Nanoparticles

There are two types of boron nanostructures that are well documented based on their morphology on which their reactivity depends [10]:

1. Amorphous boron nanoparticle
2. Crystalline boron nanoparticle [11]

### Amorphous boron nanoparticle

This form of boron nanoparticle is white in color and possess high energy density than other hydrocarbons with a high melting point of about 2300◦C [12].Besides amorphous boron nanoparticles have high thermal stability and chemical inertness due to which they are widely used in the synthesis of refractory and thermoelectric engineered nanomaterials [13,14].

### Crystalline boron nanoparticle

The crystalline boron nanoparticle exhibits a black color with a melting point of about 510 °C and density of 2.46 g/cm3 [15].Crystalline boron nanoparticles is fabricated mostly by reduction of boron trichloride with hydrogen in the vapour phase [16].Besides tetragonal boron nanowires is manufactured using solid-solid reaction [17].

## Synthesis of Boron Nanoparticles

Synthesis of boron nanoparticles is achieved using pyrolysis method which involves the mixing of an inert gas with boron gas in the plasma chamber later excited by a radio frequency to generate the desired nanoparticles of boron [18].This method offers several benefits such as it produces uniform

sized nanoparticles with a purity percentage of not less than 99% [19].And also this process is simple and suitable for mass production [20].Besides the above mentioned method there are numerous other methods used for the synthesis of boron nanoparticles such as thermal decomposition of boron halides/hydrides [21], metallothermic reduction of boron compounds at high temperatures [22],electrolytic reduction [23], arc decomposition [24] etc. The first boron nanopowder was prepared by Darvishi and coworker by mechanochemical synthesis [24].

## Applications of Boron Nanoparticles

Boron nanoparticles include a wide range of applications some of which are as follows:

- Boron nanoparticles possess narrow spectrum antibacterial activity however limited data is available regarding this aspect [25].
- Boron nanoparticles are helpful in improving the wettability performance of textile without affecting the fabric color [26].
- Boron nanoparticle based neutron capture therapy is used in the physically targeted treatment of cancer and malignant tumors [27].
- Boron nanoparticles based drugs such as Abraxane is used for the treatment of breast cancer [28].
- In addition Boron carbide based nanomaterial is used in industrial waste treatment [29].
- Boron nanoparticle is an additive for biofuel that is employed in combustion applications where it increases the overall heat and reduces the agitation temperature [30].

Examples of Products Derived From Boron Nanoparticle

- Abrasive materials
- Air bags triggers
- Alloy based glass coatings
- Bleaching agents
- Catalysts
- Disinfecting agents
- Neutron analyzer
- Rocket propellant
- Refractory materials
- Super conducting wires/tapes etc. [31-33]

## Conclusion

Thus boron nanoparticles exhibits elevated thermal and electrical resistance which makes them suitable to be used in a wide range of electrical and mechanical applications. However more research is required to explore its unique properties to expand its usage in potential applications.

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