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PII: S0040-6031(17)30058-8
DOI: http://dx.doi.org/doi:10.1016/j.tca.2017.03.007
Reference: TCA 77698

To appear in: *Thermochimica Acta*

Received date: 21-12-2016
Revised date: 6-3-2017
Accepted date: 7-3-2017

Please cite this article as: Xinhang Liu, John Gonzales, Mirko Schoenitz, Edward L.Dreizin, Effect of purity and surface modification on stability and oxidation kinetics of boron powders, Thermochimica Acta http://dx.doi.org/10.1016/j.tca.2017.03.007

Effect of purity and surface modification on stability and oxidation kinetics of boron powders

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Highlights

- Boron powder processed in acetonitrile contains less oxide
- Additional treatment in toluene makes boron more stable
- Surface modified boron has reduced activation energy of oxidation (ca. 100 kJ/mol)
- Low-temperature boron oxidation is affected by surface impurities, such as MgO
- High-temperature boron oxidation is governed by diffusion through the B_2O_3layer

Abstract

A commercial 95-% pure boron was ultrasonicated in acetonitrile and then in toluene to remove the surface layer of boron oxide and boric acid. The powder suspended in acetonitrile forms stratified layers, with the bottom layer containing most of the material with the least amount of boron oxide and boric acid. The surface of the processed boron powder was modified with a protective layer, making it more stable in room temperature humid oxidizing environment than the reference 95-% pure commercial boron. The stability of different powders was characterized using isothermal calorimetry employing a thermal activity monitor TAM III with a perfusion ampoule. Oxidation of the surface modified boron powders was studied using thermal gravimetry and compared to oxidation of both 99 and 95-% pure commercial powders. At room temperature, the 99-% pure boron powder was the most stable. Upon heating, the 99-% boron begins oxidizing at a lower temperature than all the 95-% pure powders. However, the apparent activation energy of oxidation at elevated temperatures obtained using a model-free isoconversional methodology for the 95-% pure powder processed in both