BORON POWDERS PRODUCED BY VARIOUS METHODS: FROM MORPHOLOGY TO COMBUSTION

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Abstract: The work examines microstructure, chemical composition of the oxide layer, and oxidation parameters of boron powders produced by various methods. The influence of impurities found in the surface layer of boron particles on the thermal behavior of B_2O_3, particularly its evaporation, has been studied in detail. It has been found that the presence of impurities of Al_2O_3 or MgO significantly increases the thermal stability of the boron particles oxide shell. It is shown that the combustion rate and size of condensed combustion products in B / ammonium perchlorate / paraffin model compositions are virtually independent of boron grade. However, the content of active boron in agglomerates leaving the combustion surface is significantly higher for amorphous and electrolytic boron samples, which is advantageous for using in gas generators for ramjets.

Keywords: boron; boron oxide; impurities; thermal analysis; combustion efficiency

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Figure Captions

Figure 1 The micrographs of the boron powders showing the particle morphology (left) and surface layer thickness (right): (*a*) sample No. 1; (*b*) No. 2; (*c*) No. 3; and (*d*) sample No. 4

Figure 2 Oxidation of boron samples during linear heating in air flow: (*a*) temperature dependences of sample masses; and (*b*) heat flux

Figure 3 *In situ* video recording of boron oxide particles heated at a constant rate in air in an aluminum crucible: (*a*) 160 °C, particles after dehydration; (*b*) 372°C, progressing liquefaction of particles; and (*c*) 426°C, formation of large spherical droplets of the melt. The frame width is 1.5 mm

Figure 4 Enlarged image of the high-temperature region of the dependence of the mass loss rate of the samples of pure boron oxide and boron oxide with additives on temperature during heating in an inert medium: *1* — B_2O_3, 10 K/min; *2* — B_2O_3, 2 K/min; *3* — B_2O_3/MgO; *4* — B_2O_3/Al_2O_3; *5* — B_2O_3/MgF_2; and *6* — B_2O_3/B

Figure 5 Mass change dependencies of the condensed combustion products under heating in air flow. The active boron content is evaluated by the mass increase at heating above 600 ° C

Table Captions

Table 1 Boron samples, methods for obtaining them, specific surface S_{sp}, and mean particle size D_{43}

Table 2 Elemental composition of boron particles and chemical compositon of the surface

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