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Effect of gas generator pressure on the physicochemical, oxidation and combustion characteristics of boron-based propellant primary combustion products

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Abstract

To clarify the effect of gas generator pressure on the physicochemical, oxidation and combustion characteristics of the condensed primary combustion products of boron-based propellants, the elemental, composition and morphology of the primary combustion products collected under chamber pressure of 0.2–8 MPa were investigated by energy-dispersive (EDS), X-ray photoelectron spectroscopy and scanning electron microscopy with energy-dispersive (SEM–EDS) individually. The oxidation, ignition and combustion behaviors of these products were further studied by laser ignition system and thermogravimetry–differential scanning calorimetry. We found out that high-pressure condition lowered the content of elementary boron and elementary carbon while raised the content of boron carbide. Numerous spherical carbon particles with a diameter around 100 nm were observed in the products. Boron lumps were partially or almost fully covered with carbon particles on the surface. The reaction mechanisms of thermal oxidation of primary combustion products were given. The onset temperature of boron in the products kept at 500 °C when pressure ranged from 3 to 8 MPa but increased to 583 °C at 0.2 MPa. As the pressure increased from 0.2 to 8 MPa, the emission spectrum intensity of both boron and carbon got enhanced by ~25%, and the ignition delay of boron was significantly shortened by 515 ms. In conclusion, high gas generator pressure is favorable to the secondary ignition and combustion of primary combustion products.