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Effect of carbon dioxide concentration on the combustion characteristics of boron agglomerates in oxygen-containing atmospheres

Key words: Boron combustion; Amorphous boron; Boron-containing propellant; Solid fuel ramjet

Research Summary

This article mainly focused on the effect of CO₂ concentration present in an oxygen-containing atmosphere on the combustion characteristics and oxidation mechanisms of boron agglomerates.

The samples used in the tests and schematic diagram of the experimental setup is below.

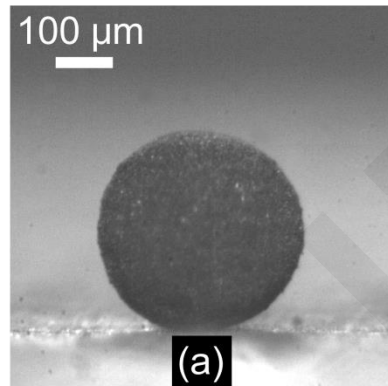


Fig. 1 Amorphous boron agglomerate

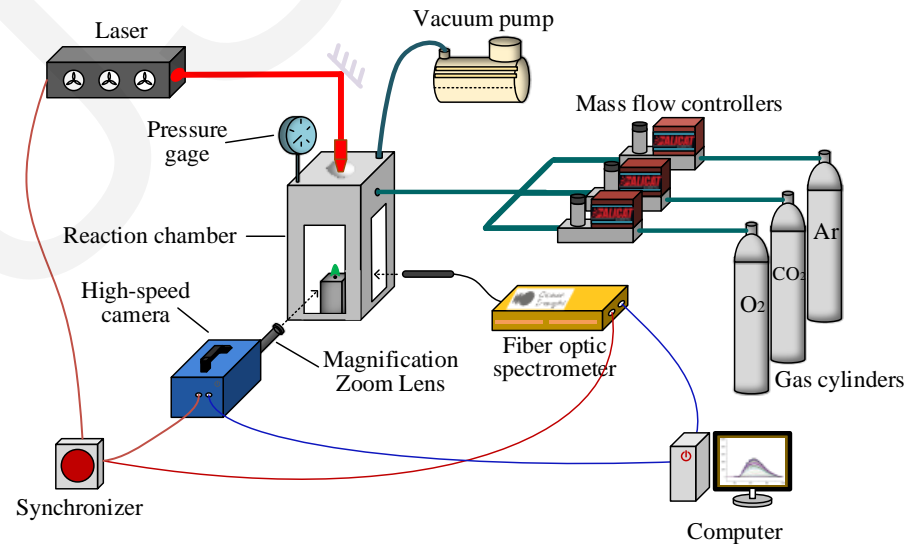


Fig. 2 Schematic diagram of the laser-ignition experimental system

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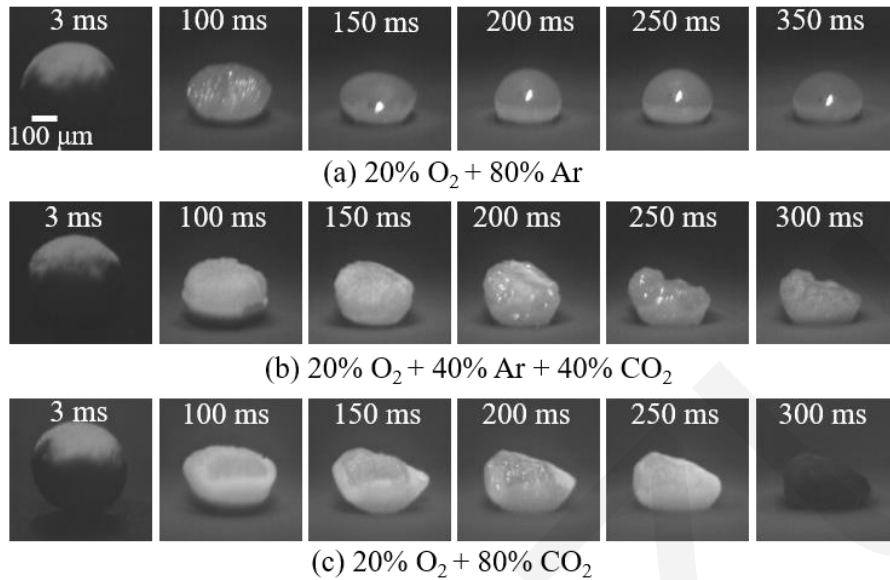


Fig. 3 Surface morphologies evolution of boron agglomerates with different CO₂ concentrations

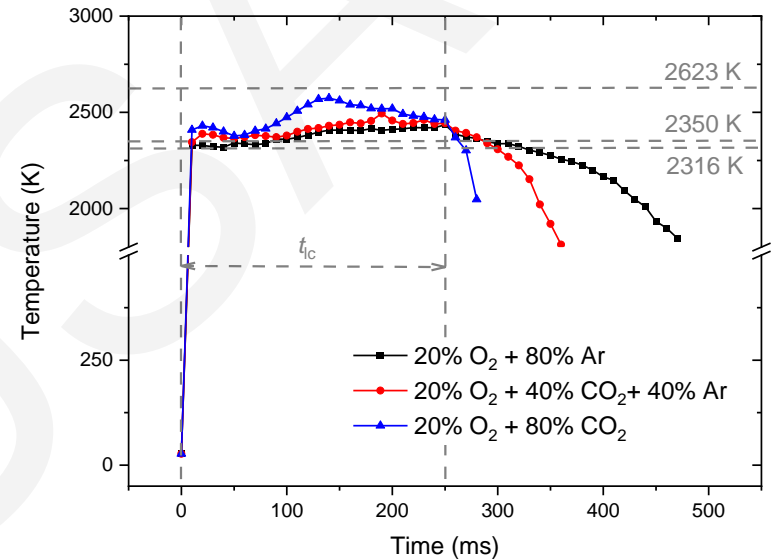


Fig. 4 Temperature variation of the boron agglomerates with different CO₂ concentrations

Innovation points

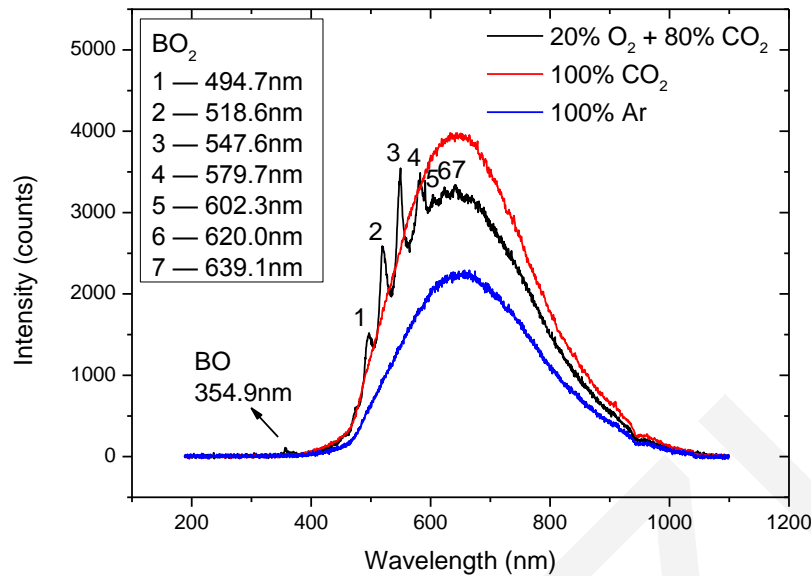


Fig. 5 Combustion spectra with the maximum intensity for boron agglomerates in different atmospheres

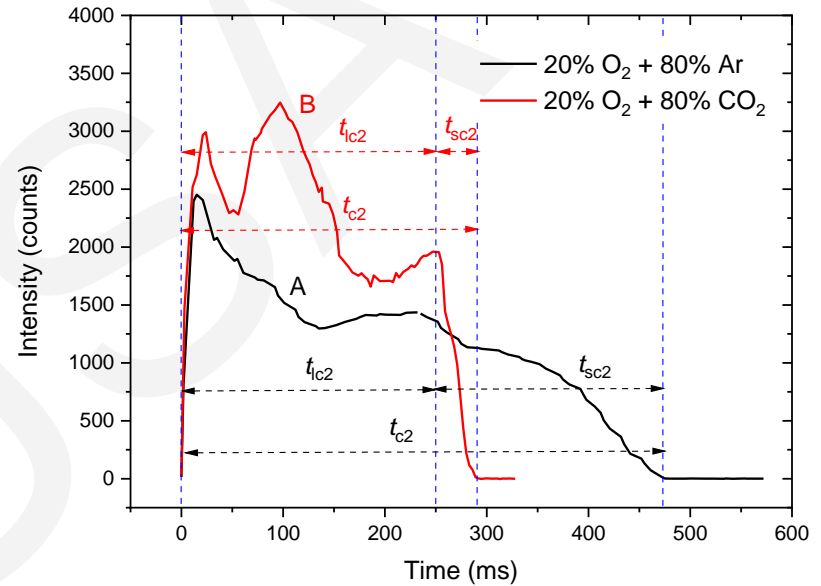


Fig. 6 Temporal variation of spectral intensity at a wavelength of 547.6 nm

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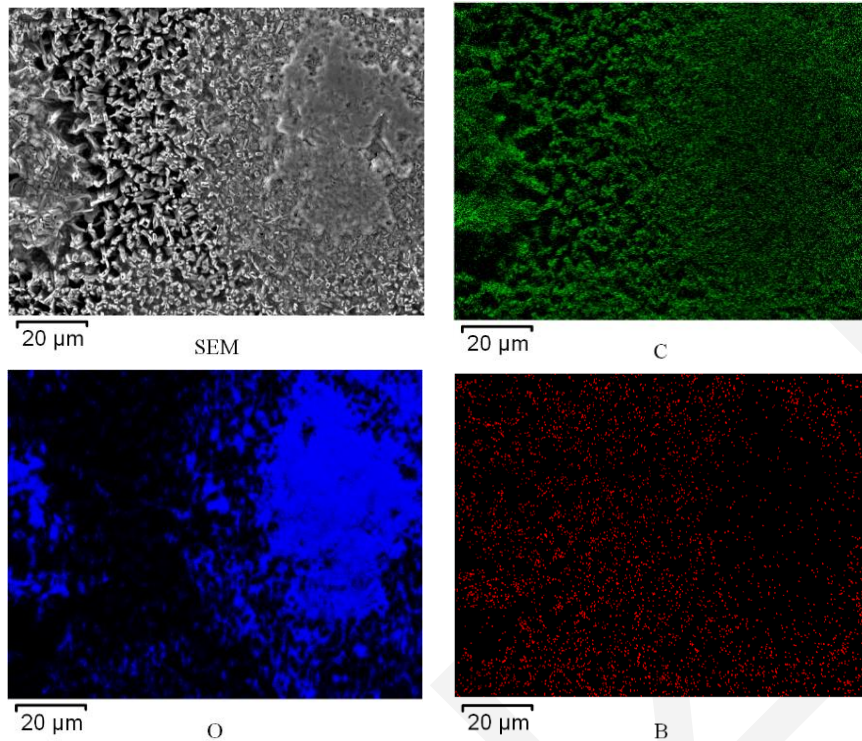


Fig. 7 Reference image of SEM, and EDS elemental maps corresponding to element C (green points), O (blue points), and B (red points)

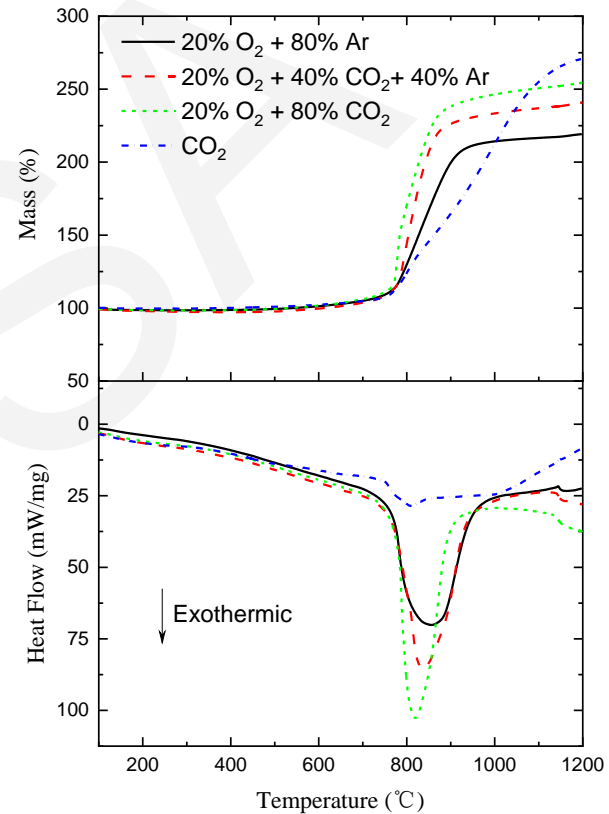
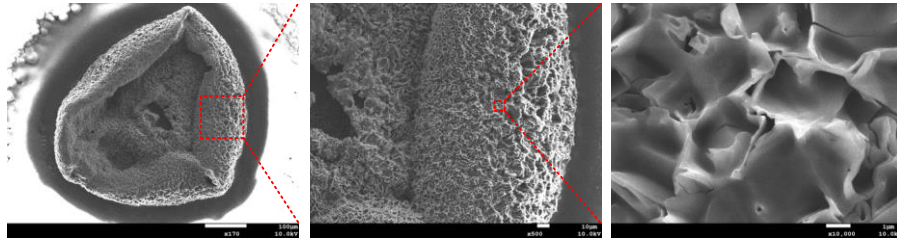
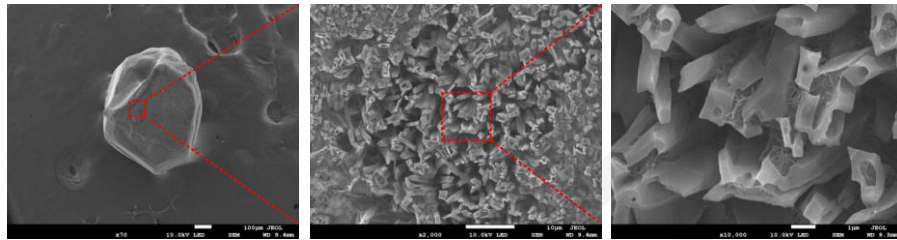


Fig. 8 TG and DSC traces of amorphous boron in different atmospheres

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(a) CCP of boron agglomerate in 20% O₂ + 80% CO₂ atmosphere



(b) CCP of single-particle boron in 20% O₂ + 80% CO₂ atmosphere

Fig. 9 FE-SEM images of condensed-phase combustion products (CCPs)

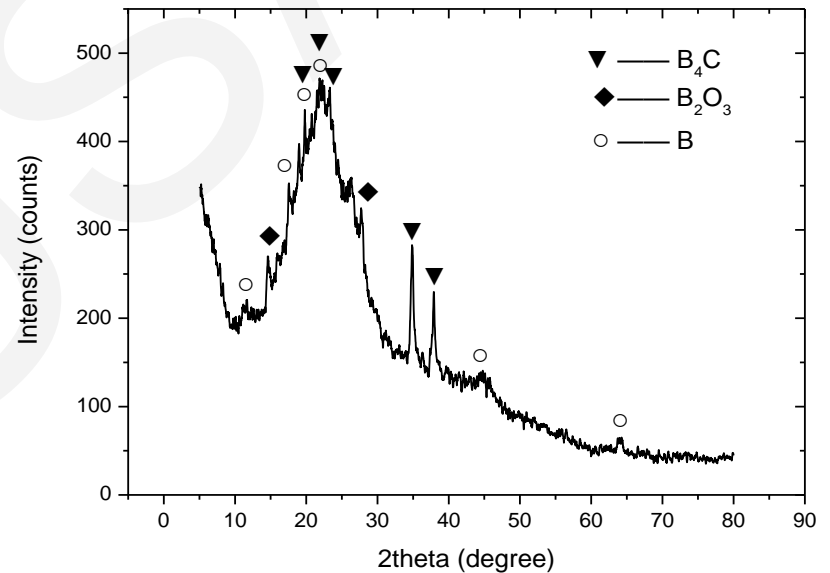
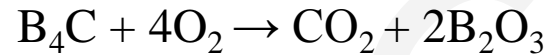


Fig. 10 XRD pattern of CCPs in 20% O₂ + 80% CO₂ atmosphere

Conclusions

Boron agglomerates can react with CO₂ in an oxygen-containing atmosphere at high temperature to form B₄C:



With a fixed oxygen concentration of 20%, an increase in CO₂ content causes the combustion process of boron agglomerates to transition from single-particle molten droplet combustion to porous-particle combustion.

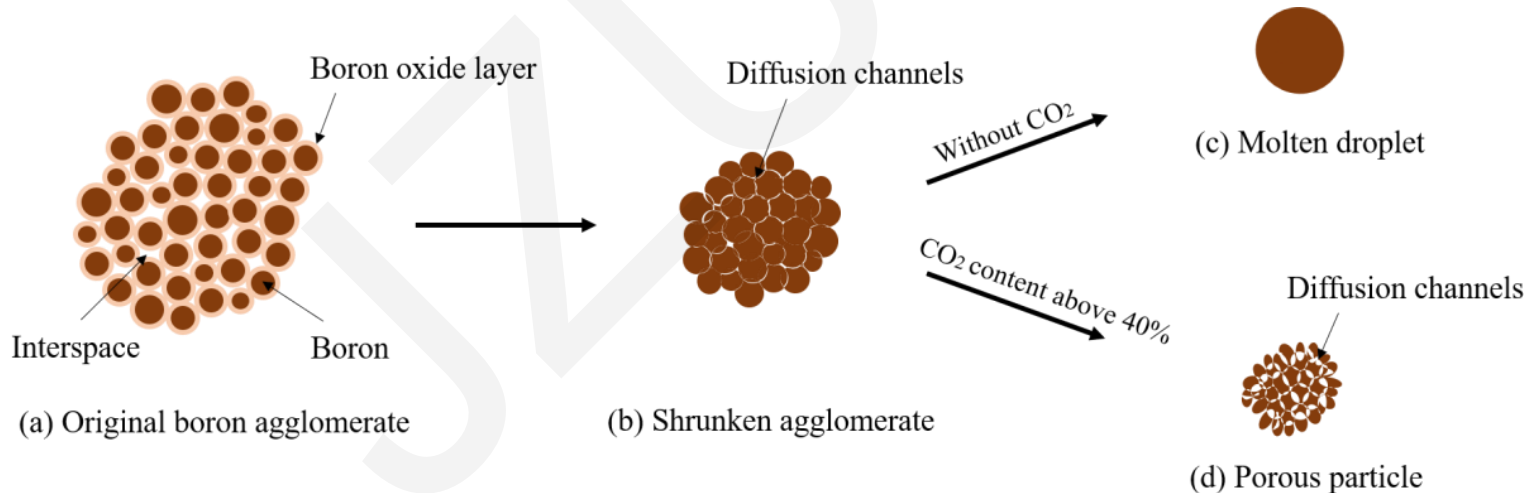


Fig. 11 A schematic of the internal structural evolution of boron agglomerates during heating and combustion