

Purity and Surface Area Effects on the Thermal Stability and Oxidation Resistance of Boron Nitride Nanomaterials

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Hexagonal boron nitride (h-BN) nanomaterials, including nanoplatelets and nanotubes, were systematically investigated with respect to their thermal stability and oxidation behaviour. h-BN nanoplatelets with varying purity levels, surface areas, porosity and morphology were synthesized and characterized by X-ray diffraction, Fourier-transform infrared radiation, X-ray photoelectron spectroscopy, scanning electron microscopy, gas sorption analysis and thermal gravimetric analysis coupled with differential scanning calorimetry under synthetic air up to ~1300 °C. The results reveal a strong dependence of thermo-oxidative stability on both purity and accessible surface area. High-purity, low-surface-area samples exhibited superior oxidation resistance, remaining stable up to ~1000 °C, with oxidation occurring mainly between ~1000-1200 °C and forming B₂O₃. In contrast, higher-surface-area or defect-rich materials initiated oxidation at lower temperatures (~860-1000 °C), highlighting the role of defects and reactive sites in oxygen diffusion. A comparison with high-purity carbon nanotubes further demonstrated the intrinsic oxidation resistance of BN nanostructures, which remained stable at significantly higher temperatures. These findings underline the critical importance of purity and surface area control for optimizing BN nanomaterials in high-temperature oxidative environments.

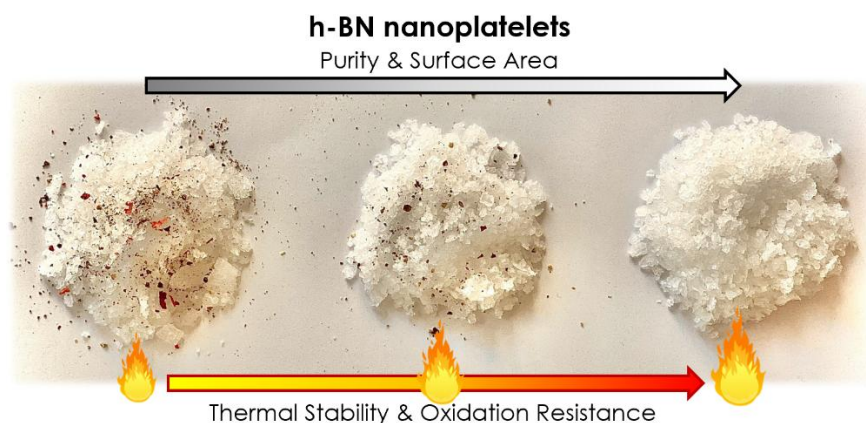


Figure 1. Schematic representation of the effects of purity and surface area on the thermo-oxidative stability of h-BN nanoplatelets.

References

- [1] N. Kostoglou, K. Polychronopoulou, C. Rebholz, *Vacuum*, 112 (2015) 42-45.
- [2] N. Kostoglou, J. Lukovic, B. Babic, B. Matovic, D. Photiou, G. Constantinides, K. Polychronopoulou, V. Ryzhkov, B. Grossmann, C. Mitterer, C. Rebholz, *Materials and Design*, 110 (2016) 540-548.
- [3] N. Kostoglou, C. Tampaxis, G. Charalambopoulou, G. Constantinides, V. Ryzhkov, C. Doumanidis, B. Matovic, C. Mitterer, C. Rebholz, *Nanomaterials*, 10 (2020) 2435.
- [4] N. Kostoglou, S. Stock, A. Solomi, D.M. Holzappel, S. Hinder, M. Baker, G. Constantinides, V. Ryzhkov, J. Maletaskic, B. Matovic, J.M. Schneider, C. Rebholz, C. Mitterer, *Nanomaterials*, 14 (2024) 601.