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Incorporation of One or More Carbon Atoms into the Boron Icosahedra

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ABSTRACT

Boron carbide has a complex crystal structure typical of icosahedron-based borides. There, B12 icosahedra form a rhombohedral lattice unit (space group: R3m (No. 166), lattice constants: a = 0.56 nm and c = 1.212 nm) surrounding a C-B-C chain that resides at the center of the unit cell, and both carbon atoms bridge the neighboring three icosahedra. This structure is layered: the B12 icosahedra and bridging carbons form a network plane that spreads parallel to the c-plane and stacks along the c-axis. The lattice has two basic structure units – the B12 icosahedron and the B6 octahedron. Because of the small size of the B6 octahedra, they cannot interconnect. Instead, they bond to the B12 icosahedra in the neighboring layer, and this decreases bonding strength in the c-plane. The results of this study indicated that boron carbide (B4C) powder has been cleanly penetrated to the poly(methyl methacrylate) (PMMA) with little observed deformation.

Because of the B12 structural unit, the chemical formula of "ideal" boron carbide is often written not as B4C, but as B12C3, and the carbon deficiency of boron carbide described in terms of a combination of the B12C3 and B12C2 units. Some studies indicate the possibility of incorporation of one or more carbon atoms into the boron icosahedra, giving rise to formulas such as (B11C)CBC = B4C at the carbon-heavy end of the stoichiometry, but formulas such as B12(CBB) = B14C at the boron-rich end. "Boron carbide" is thus not a single compound, but a family of compounds of different compositions. A common intermediate, which approximates a commonly found ratio of elements, is B12 (CBC) = B6.5C.

Quantum mechanical calculations have demonstrated that configurationally disorder between boron and carbon atoms on the different positions in the crystal determines several of the materials properties - in particular, the crystal symmetry of the B4C composition and the non-metallic electrical character of the B13C2 composition. B4C powder and PMMA integration was observed at the cracking surface at both od side of PMMA. Boron carbide powder was used to examine crack nucleation, propagation, and coalescence on PMMA. The rise of borax amount in PMMA caused to decrease the detection of the cracking within the composite as a function of borax amount. Two experimental configurations were used to obtain such data and each highlighted the practical difficulties associated with the measurements. This demonstrated the need for well-defined and systematic series of experiments to examine single crack behavior. Further effort is evaluated to provide quantitative interpretation of cracking and to extend the service life of PMMA with the densification.

Biography

N Baydogan is a Prof. Dr at Istanbul Technical University, Energy Institute, Nuclear Researches Division, Istanbul, Turkey. She studied physics in Istanbul University, Turkey. She received MSc. and PhD. from Istanbul Technical University, Nuclear Energy Institute. Her research is at the interface where ionizing radiation and materials meet: radiation source, nanomaterial, polymer nanocomposites, thin film deposition. She is best known for work on the applications of nuclear techniques.