PROBING CRYSTALINE PHASES IN CUBIC BORON NITRIDE AS A FUNCTION OF BORON CONTENT BY MASSIVE NANOINDENTATION AND MICROSAMPLE TESTING

Joan Josep Roa, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain
joan.josep.roa@upc.edu
Joel Cugnoni, Laboratoire de mécanique appliquée et d'analyse de fiabilité, École Polytechnique Fédérale de Lausane, CH-1015 Lausanne, Suisse
Hossein Besharatloo, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain
Victor Lamelas, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain
Saloua Abouelaz, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain
Emilio Jiménez-Piqué, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain
Luis Llanes, CIEFMA-Dept. Materials Science and Engineering, Universitat Politècnica de Catalunya, EEBE-Campus Diagonal Besòs, 08019 Barcelona, Spain

Key Words: Massive Nanoindentation, mechanical mapping, Microsamples, strength, tomography, finite element modelling

Polycrystalline cubic boron nitride (cBN) is a super-hard multiphase composite is extensively used in highly demanding applications, where improved and consistent performances together with high reliability are required. The remarkable mechanical properties of these materials result from a two-fold effectiveness associated with its composite character. On the one hand in terms of composite nature: combination of a brittle cBN particles and a ceramic TiN binder with optimal interface properties, as given by a very low interfacial energy and very good adhesion between cBN and TiN.

Information on the small-scale mechanical response mainly for superhard materials is rather scarce in the literature This is particularly true regarding experimental data and analysis on the influence of phase and/or chemical nature and interfacial adhesion on hardness. It is clear that knowledge of these issues is crucial not only to improve the performance of this superhard materials but also to designer of new PCBN systems, which will lead to highly desirable improvements in the cost and time on the materials development cycle.

The present work aims to evaluate the boron effect on the cBN particles by doing a systematic micro- and nanomechanical study of the mechanical integrity for different superhard systems, with different binder and reinforcement content. In doing so, different micromechanical approaches are followed:

i) Assessment of the micromechanical properties by using the statistical approach,

ii) evaluation of the fracture toughness by microcantilever deflection, strength by micropillar compression, and

iii) finite element modelling based on 3D FIB tomography is performed by using the acquired micromechanical data in order to correlate micromechanical behavior with macroscopic response of the material.

From the obtained results by the statistical method it is found that the boron content strongly modifies the cBN hardness; which produces a modification of this superhard particles being this tetragonal or octhoedrical depending the amount of the boron content dissolved inside the particle