Final Report

Project acronym: *DURACER*

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Coordinator: Dr. Piotr Klimczyk |piotr.klimczyk@ios.krakow.pl |
Institute of Advanced Manufacturing Technology | Poland

2. Publishable project summary

The aim of the DURACER project was to utilize the beneficial properties of cubic boron nitride (cBN) to obtain a new generation of Spark Plasma Sintered (SPS) tool materials and to use these materials to create high-performance cutting tools. The modification of alumina-based matrix with cBN particles improved fracture toughness and cutting performance of cutting inserts made of DURACER composites.

The main challenge was the metastability of cBN at SPS conditions. At high temperatures cBN (similarly to diamond) converts to hexagonal, graphite-like form (hBN) thus ultrahigh pressure must also be provided in order to avoid cBN-->hBN transition. Therefore, cBN composites are typically obtained by High Pressure High Temperature (HPHT) method at temperatures of 1900 – 2200°C and at pressures of 5.5 – 8 GPa. It should be mentioned that the HPHT family of sintering methods is relatively much more expensive and difficult than SPS methods. The research carried out in the project showed that it is possible to obtain cBN composites in non-equilibrium conditions using the SPS method. Thanks to the low superhard phase content in the DURACER composites (up to 30 vol.%) and the use as a bonding phase the ultrafine oxide powder characterised by relatively low sintering temperature, the composites were obtained with the use of SPS at temperatures of 1300 – 1400°C and pressures from 60 to 150 MPa (two orders of magnitude lower than in HPHT method).

Several dozens of mixtures of ceramic powders with cBN of various qualitative and quantitative compositions were prepared and subsequently sintered using SPS. Comprehensive studies of the obtained sinters carried out by the DURACER consortium partners allowed for the selection of the most promising materials. Finally, a series of cutting inserts has been manufactured from selected composites. The inserts were tested during turning of different hardened steels (60-65 HRC) and Inconel Alloy 718 using various cutting parameters. Test results are strongly dependent on the specific tool material composition, workpiece properties and cutting conditions. In general, DURACER inserts work much better than pure alumina tools (the cheapest commercially available ceramic tools) and comparable to the most advanced ceramic composites (including whiskers reinforced ceramics) offered by world leaders in the tooling industry. The tests performed indicate that DURACER tools are most suitable for machining of hardened steels but can also be successfully applied to Inconel.

Potential consumers of the project results are mainly manufacturers of tools and tools users.