TECHNOLOGICAL ASPECTS OF THE QUALITY IMPROVEMENT OF POLYCRISTALLINE DIAMOND COMPACT BITS FOR OIL AND GAS INDUSTRY

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Effectivity and durability of the drill bits used in oil and gas mining is dependent in large extent on the quality of cutting inserts. Application of the diamond-reinforced composite inserts requires special quality, especially in respect of reproducible hardness, strength and fracture toughness. The initial results indicated feasibility of the electroconsolidation method, i.e. hot-pressing with directly applied electric current through graphite molds, for fabrication of such inserts [1]. The composite material fabricated this way, exhibited high physical and mechanical strength with reproducible characteristics, which improved overall effectivity of the drill bits. In particular, Fe-Cu-Ni-Sn- based metal matrix diamond reinforced composites due to their advantageous properties can be used for mining drill bits, but also for cutting wheels, wire saws, hole saws, grinding and polishing tools for the stone industry [2,3]. Industrial fabrication of this sort of composites usually utilizes powder metallurgy methods, such as hot-pressing. The powder mixture contains catalitically syntesized diamond powders with grains 315/250–500/400, while powders of iron, copper, nickel, and tin have particle of size 5-60 μm. Other method is pressing in molds with subsequent repressing, spark plasma sintering (SPS), high frequency inductive sintering, pulse plasma sintering, etc. Dependent on the method used, the structure of the diamond-reinforced composite is formed in temperatures between 700 °C and 1000 °C under pressure of 20-200 MPa.

It was found that addition of the 3 wt% of VN nanopowder of particle size 10-60 μm to the initial composition 51% Fe – 32% Cu – 9% Ni – 8% Sn improved structure and, hence, properties of the composite. In particular, after electroconsolidation, nanostructural features appeared, with grains of dimensions between 20 and 400 nm and dense boundaries between them. Presence of no defects or pores was found in these nanostructures. Its composition consisted of the oversaturated solid solution of nitrogen and vanadium in α-Fe, as well as intermetallic compound Cu_9NiSn_3 and primary and secondary dispersed phases of vanadium nitride. The results of nanostructural formation through phase transformation $\alpha \rightarrow \gamma \rightarrow \alpha$ during electroconsolidation are of great practical interest. Hot-pressing process strengthen the alloy and ensure properties beneficial from the perspective of polycristalline diamond compact bits performance and durability. Peculiarities of the electroconsolidation process allow for high repeatability and reproducibility of the characteristics of diamond reinforced nanostructural metal matrix composites.

References

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ACCURACY ANALYSIS OF THE APPOINTMENT OF PART COORDINATE SYSTEM IN CMM

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Measurement with Coordinate Measuring Machines (CMMs) consists of determining the spatial coordinates of measurement points on the surface of a measured object, and then calculations are performed to determine the best-fitting geometrical elements [1]. From these elements, dimensions of the measured object are derived. Usually, a contact measurement is completed with a stylus equipped with a ball tip maintaining the same distance between its center and the measured surface in all directions [2]. Among many sources of uncertainty, determination of Part Coordinate System (PCS) may affect all the subsequent measurement results. This study is devoted to the analysis of PCS appointment accuracy. Figure 1a presents the machine used in experiments, and 1b shows the measured gage block with PCS based on 4 probing points placed on each side. Their positions are shown with red circles on the visible surfaces, but similar positions are in the plane YZ.

a)

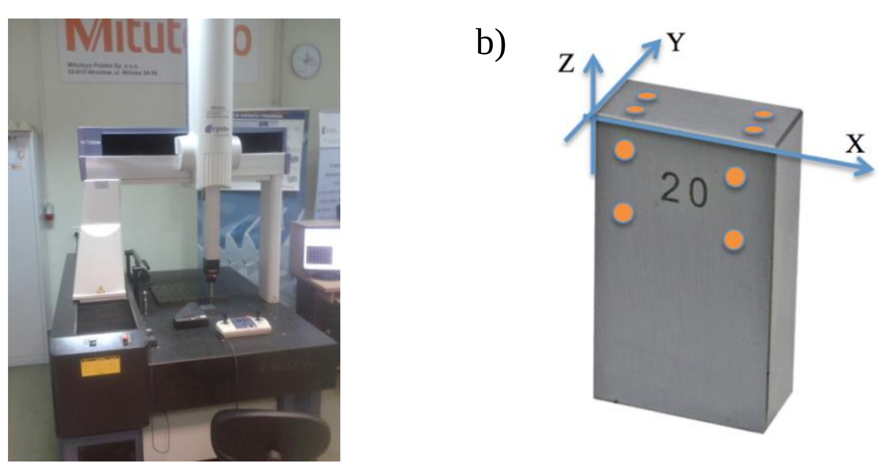

Figure 1. Experimental setup: a) CMM Mitutoyo Crysta-Apex C7106, b) measured gage block with appointed Part Coordinate System

Theoretically, accurate identification of the probing points should provide accurate determination of the PCS XYZ. However, when measuring such an accurate object as a gage block, the results appeared to be dependent on the measurement method. Four methods were tested, defined as follows:

- method 1 involved coordinate *X* of the probing point placed on the gage block’s right surface (Fig. 1);
- method 2 involved measurement of the distance between two points between two face surfaces, right and left ones, along the axis *X*;
- method 3 involved coordinate *X* of the probe ball tip center when touching right face surface minus ball radius;