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Effect of diamond grain size on magnetic properties of cobalt phase in PCD

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Abstract content
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Polycrystalline diamond (PCD) table comprises diamond grains, which are non-magnetic, a metal phase (cobalt-base), which is the only ferromagnetic component in the material and WC which is non-magnetic and which moves into PCD during cobalt infiltration. Experiments were conducted to determine the magnetic saturation and coercive field strength of PCD and relate them to image analysis results.
Three variants of diamond powders were selected for this study. These had average particle diameters of 4.5µm, 12.5µm, and 25.3µm respectively. WC-Co substrates readily available and sintered at ElementSix (PTY) Ltd containing 13 wt. % Co were used to sinter the PCD table onto the WC-Co. These substrates were sintered at 1400℃ and a pressure of 40mbar to form a dense body. The PCD tables were separated from the substrate, prepared for analysis and characterized for magnetic saturation, coercivity and microstructure, including image analysis. The magnetic values were correlated with analytical image analysis results.
Clear correlations between metal phase content and magnetic saturation and cobalt mean free path and coercivity exists. It was found that magnetic saturation measurements are independent of the shape and size of the specimen. As the particle size of a non-magnetic material increases, the number of magnetic domains of the metallic phase increases, and therefore the coercive force decreases.
It is found that the diamond starting particle size has large influence on the metallic phase microstructure and magnetic properties. Furthermore, the more fine grain diamond particles have higher sintered density over coarser diamond particles indicating a higher volume fraction of metallic cobalt. This is confirmed by the high values of magnetic saturation measurements for fine grain diamond over coarse grain one.

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