World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:18, No:09, 2024

Tailoring Polycrystalline Diamond for Increasing Earth-Drilling Challenges

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Abstract : Polycrystalline diamond compact (PDC) cutters with a polycrystalline diamond (PCD) table supported by a cemented tungsten carbide substrate have been widely used for earth-drilling tools in the oil and gas industry. Both wear and impact resistances are key figure of merits of PDC cutters, and they are closely related to the microstructure of the PCD table. As oil and gas exploration enters deeper, harder, and more complex formations, plus increasing requirement of accelerated downhole drilling speed and drilling cost reduction, current PDC cutters face unprecedented challenges for maintaining a longer drilling life than ever. Excessive wear on uneven hard formations, spalling, chipping, and premature fracture due to impact loads are common failure modes of PDC cutters in the field. Tailoring microstructure of the PCD table is one of the effective approaches to improve the wear and impact resistances of PDC cutters, along with other factors such as cutter geometry and bit design. In this research, cross-sectional microstructure, fracture surface, wear surface, and elemental composition of PDC cutters were analyzed using scanning electron microscopy (SEM) with both backscattered electron and secondary electron detectors, and energy dispersive X-ray spectroscopy (EDS). The microstructure and elemental composition were further correlated with the wear and impact resistances of corresponding PDC cutters. Wear modes and impact toughening mechanisms of state-of-the-art PDCs were identified. Directions to further improve the wear and impact resistances of PDC cutters were proposed.

Keywords : fracture surface, microstructure, polycrystalline diamond, PDC, wear surface
Conference Title : ICSMS 2024 : International Conference on Superhard Materials and Structures
Conference Location : San Francisco, United States
Conference Dates : September 26-27, 2024