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Micro-Raman and X-ray Diffraction stress analysis of residual stresses in fatigue loaded leached Polycrystalline Diamond

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X-ray diffraction and Raman spectroscopy techniques were used to investigate residual stresses in polycrystalline diamond disc samples sintered using the high temperature, high pressure method in the presence of a cobalt solvent/catalyst. The metallic phase primarily aids the formation of diamond to diamond bonds during sintering. During harsh rock drilling applications at elevated temperatures, the same cobalt expands more than the diamond, straining the diamond matrix and leading to premature failure of the component [1]. Since the PCD material formed is virtually a two-phase material comprising of cobalt and diamond, substantial volumes of the metallic phase can be removed through a leaching process without compromising the cohesiveness of the diamond matrix [2]. The leaching process reportedly results in a product with improved thermal stability and overall improved wear resistance. A systematic investigation and evaluation of the average in-plane residual stress fields on fatigue loaded leached PCD disc samples were undertaken. Whilst the Raman results reported a progressive shift of the residual stresses from an average compressive stress state to an average tensile stress state with an increasing number of loading cycles, the X-ray diffraction method recorded compressive stresses throughout. This apparent disagreement in results is likely due to differences in the way the two methods measure the residual stresses. Our results in this regard are presented and discussed in the context of several other reports of similar discrepancies in stress result measurements as reported by the Raman spectroscopy and the X-ray diffraction method.

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