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X-ray diffraction and Raman spectroscopy based residual stress measurements for assessment of fatigue in leached polycrystalline diamond tool bits

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Abstract content
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Polycrystalline diamond (PCD) cylindrical tool-bits are complex materials systems. One aspect that has a significant influence on the in¬–service behaviour and lifetime is the residual macro-stress state created as a result of the difference in coefficients of thermal expansion (CTE) between the diamond table and the WC-Co substrate. Leached PCD, where the near-surface cobalt has been removed from the PCD layer, has a longer in-service lifetime and the reasons for this are not well understood. The measurement and study of the average in-plane stress fields on the surface of the PCD thus becomes crucial in understanding the in–service behaviour with the quest to have an extended life for the tool-bits. Two complementary non-destructive techniques namely Raman spectroscopy and X-ray diffraction have been employed for residual stress measurements on detached PCD layer samples of 16 mm in diameter and 2 mm in thickness. The Raman peak reveals both the nature and magnitude of the stress present in the material but it is essentially a surface technique with the depth penetration of the visible light being limited by the transparency of the PCD to only a few microns. The X-ray Diffraction technique probes the change in the spacing of the atomic planes of the diamond crystals with strain and has a larger penetration depth. Employing the ball on three balls fatigue set-up the samples were cyclically loaded under constant amplitude load control at a frequency of 10 Hz at room temperature and pressure conditions. Raman and XRD residual stress measurement were done as a function of the number of fatigue cycles to study the surface and near-surface stress under increasingly severe fatigue conditions. These are compared with published Raman spectroscopy results on unleached PCD.

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and his / her institution

Dr Rudolph Erasmus
Rudolph.Erasmus@wits.ac.za
School of Physics
University of the Witwatersrand

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Primary author: Mr VHARETA, Maxwell (DST/NRF Centre of Excellence in Strong Materials, University of the Witwatersrand)

Co-authors: Prof. COMINS, Darrell (University of the Witwatersrand); Dr ERASMUS, Rudolph (University of the Witwatersrand)

Presenter: Mr VHARETA, Maxwell (DST/NRF Centre of Excellence in Strong Materials, University of the Witwatersrand)

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