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Initial studies into the micro-abrasion resistance of CVD Diamond coatings

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ABSTRACT

A Plint TE 66 micro-abrasion tester has been used to determine the abrasion resistance of several commercially available micro-wave plasma or hot filament CVD Diamond coatings deposited on sintered silicon carbide or tungsten substrates. All coatings had a Raman spectrum comparable with natural diamond. Initial results on 3 to 120 μm thick coatings are presented. The tests used 25.4-mm diameter balls of tungsten carbide or hardened steel with normal loads from 0.25 to 2N and sliding speeds of 1 to 1.5 m/s. Both 4.5 μm sic and 6 μm diamond slurries were used as abrasives. The sliding distance for each test varied bewteen 8m to 800m. Results show that most coatings have a steady state wear rate of about 2.5×10^{-14} m^3/Nm, see Figure 1. These wear rates compare well with those for a PVD Diamond Like Carbon (DLC) thin coating (approx 2 μm thick on sintered tungsten carbide) which has a specific wear rate of 1×10^{-12} m^3/Nm. Initial work investigating the dependence of wear rate on coating thickness, ball material and abrasive material are discussed.

The wear mechanisms within the wear craters are examined using scanning electron microscpy. Deep grooving/scoring are present on some scars suggesting the abrasive/wear debris has become embedded in the ball. Other regions are smooth and suggest three-body abrasion is present which results in micro-chipping of the diamond grains.

Some regions have signs of a smeared smooth dark deposit that could be graphitic in nature. Micro-Energy Dispersive X-Ray Spectroscopy shows only a carbon composition for these regions.

A 3-D Talysurf profilometer with surface mapping software and sphere fitting routines have been used to analysis the wear craters produced. 3-D surface profilometry provides valuable information of the actual crater geomerty such as depth. The sphere fitting allows the 'misfit' between ball radius and crater radius to be evaluated and residuals defined representing wear deviations within the crater (i.e.pitting). Volume loss calculations from the surface mapping using Simpsons 3-D approximation generate lower specific wear rate values compared to those generated using the microscope on the rig and assuming spherical craters are formed.

Figure 1: Ball cratering of CVD diamond coatings