Thermal damage study on diamond tools at varying laser heating time and temperature by Raman spectroscopy and SEM

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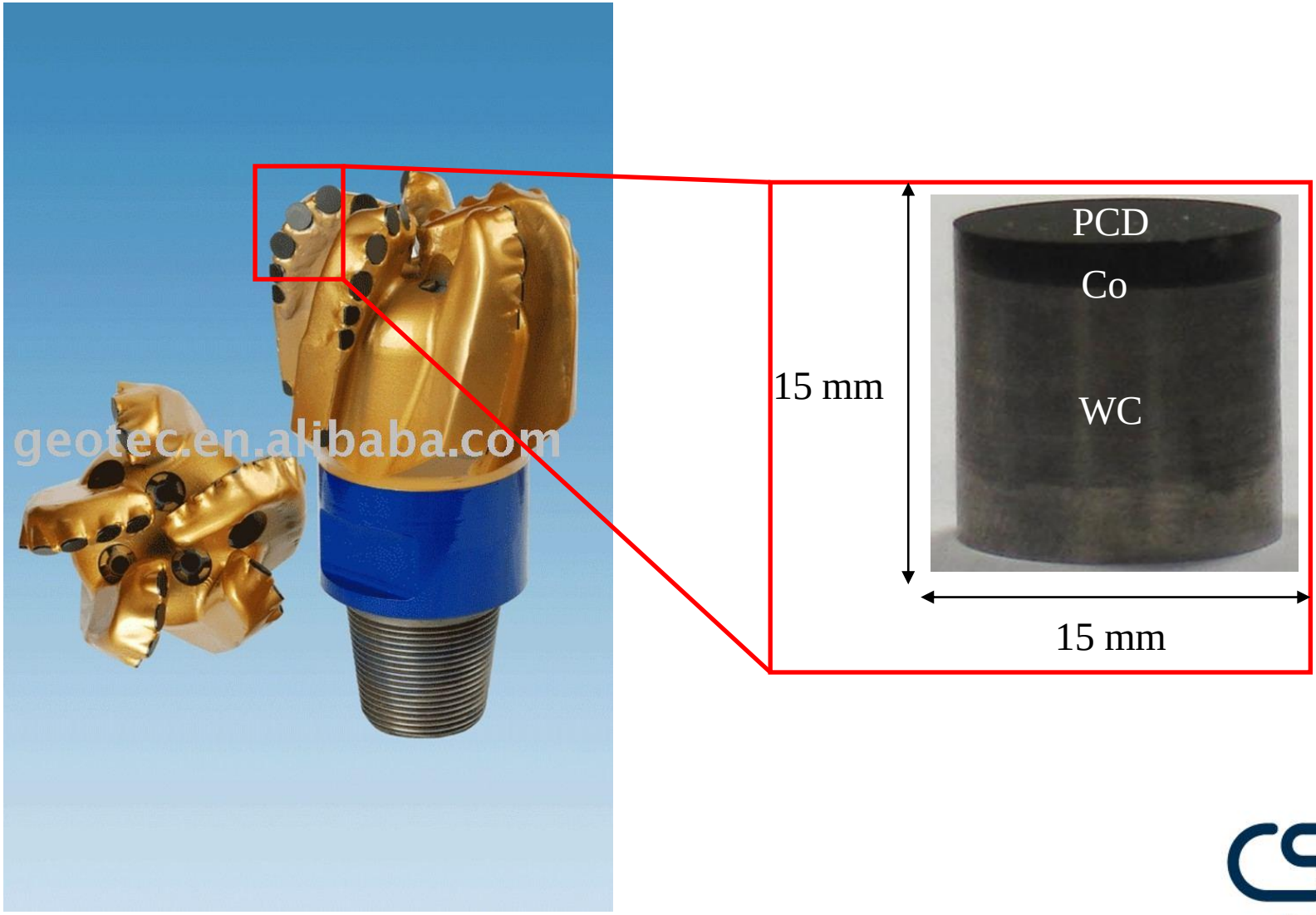
Diamond tools for oil and gas drilling

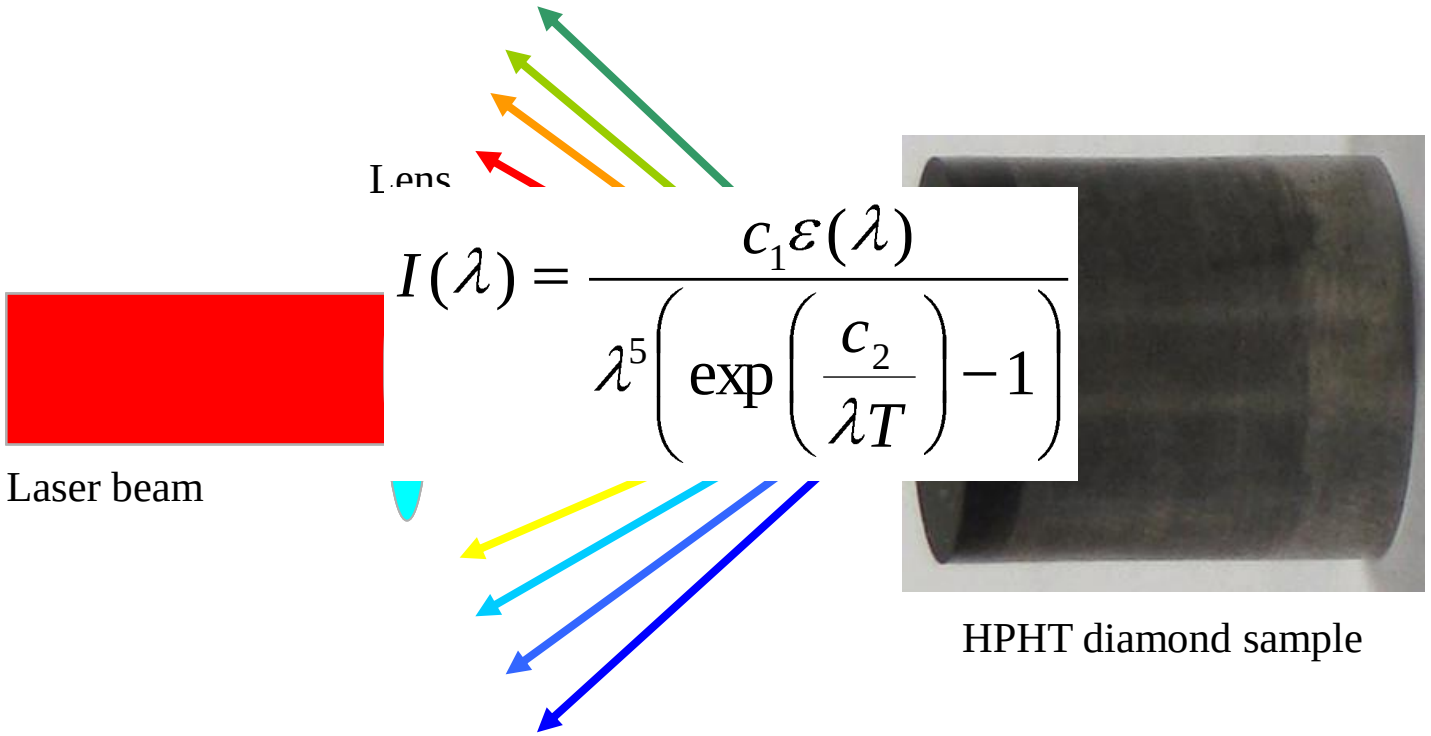
Typical drilling tool



At present it is known that diamond tool degrades with time as it is normally used at high temperatures

One of the question we like to answer in this study **is whether thermally induced problems in diamond tool arise as a result of the temperature value itself?**

We raised the temperature of the diamond tool sample by laser heating it



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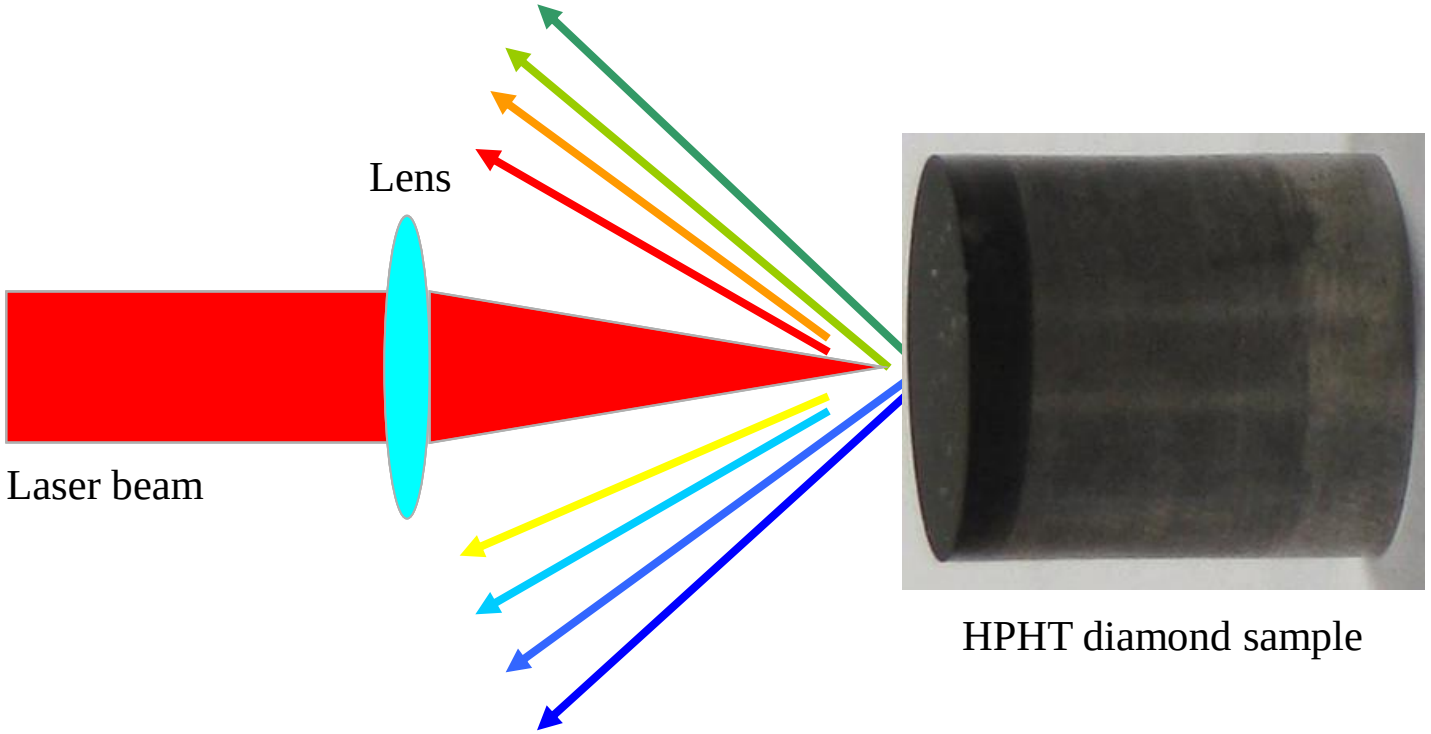


Experimental setup

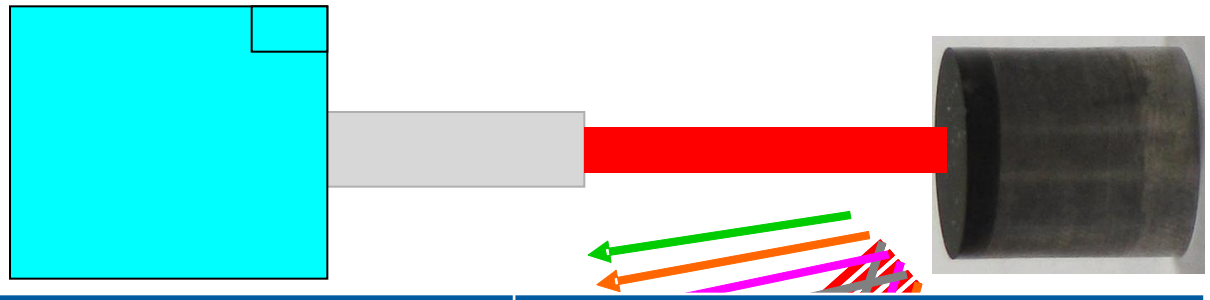
HPHT diamond sample

Fibre laser,

λ = 1064 nm,

ω = 2,2 mm,

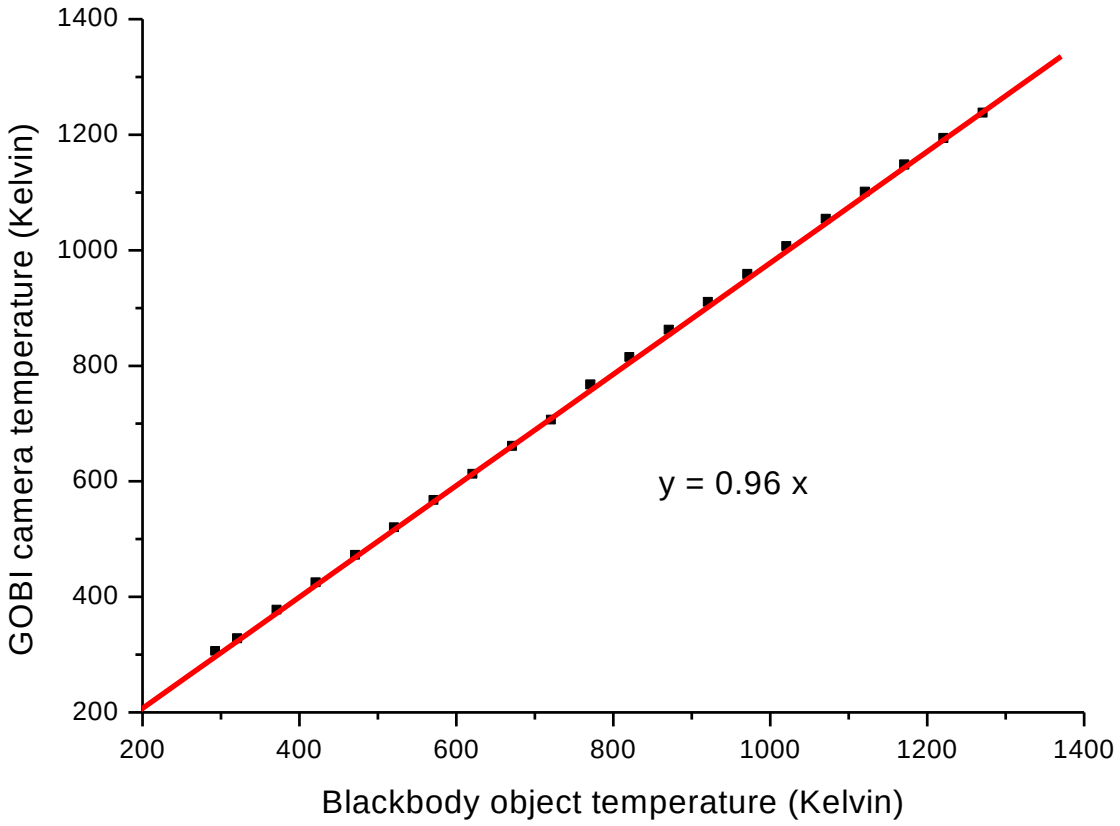
P = 50 W.



Types camera	GOBI - camera
Arrays type	Uncooled microbolometer (a-Si)
Spectral band	8 µm – 14 µm
Numbers of pixels	384 - 288
Pixels pitch	25 µm
Temp. range	Room temp. – 1000 °C

ion

Characterisation curve



Physical changes on the diamond tool samples due to the laser heating

Initial

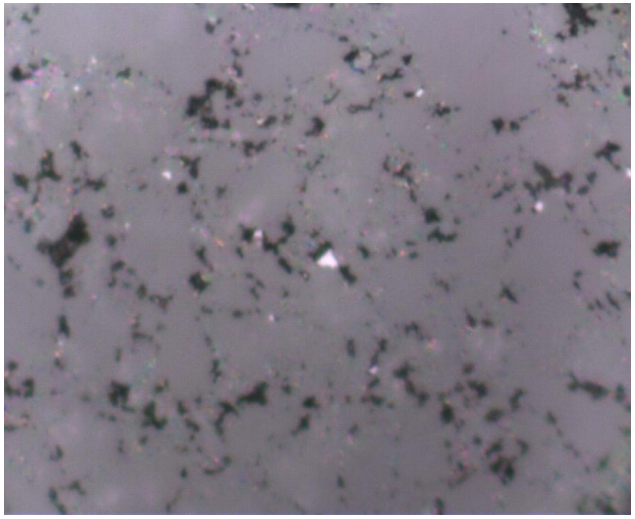
5 min – 895 K

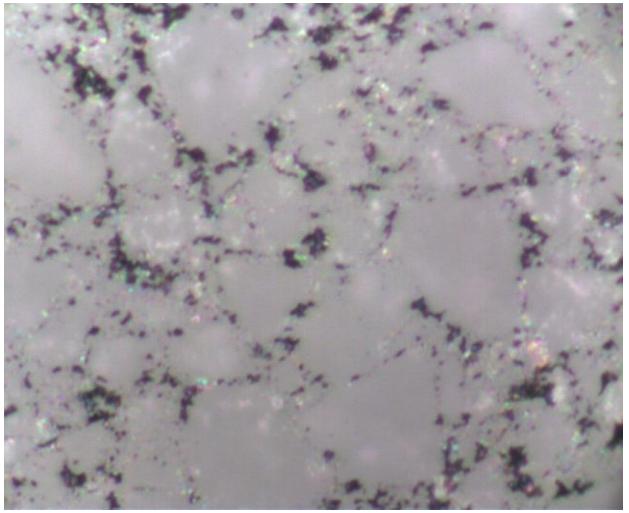
15 min – 968 K

25 min – 979 K

Optical images at the surface of the PCD layer

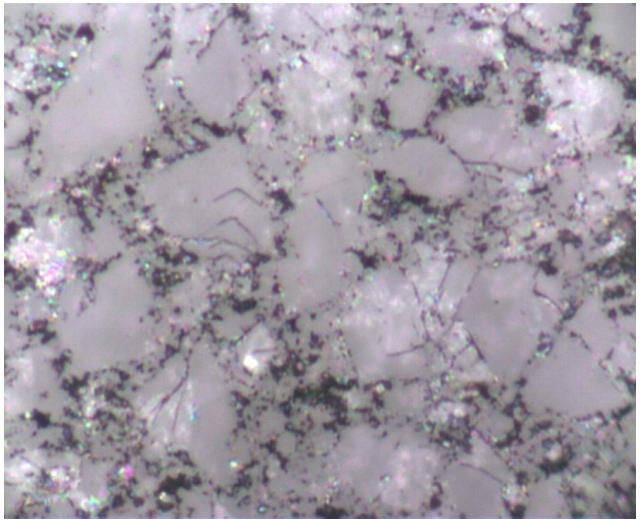
Initial

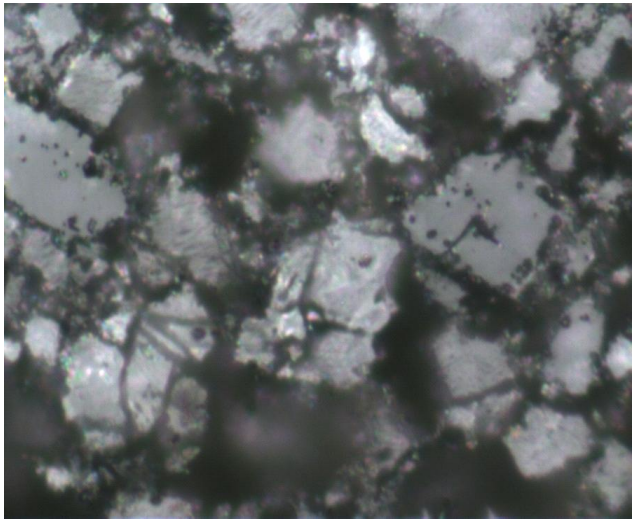




5 min
895 K

15 min
968 K

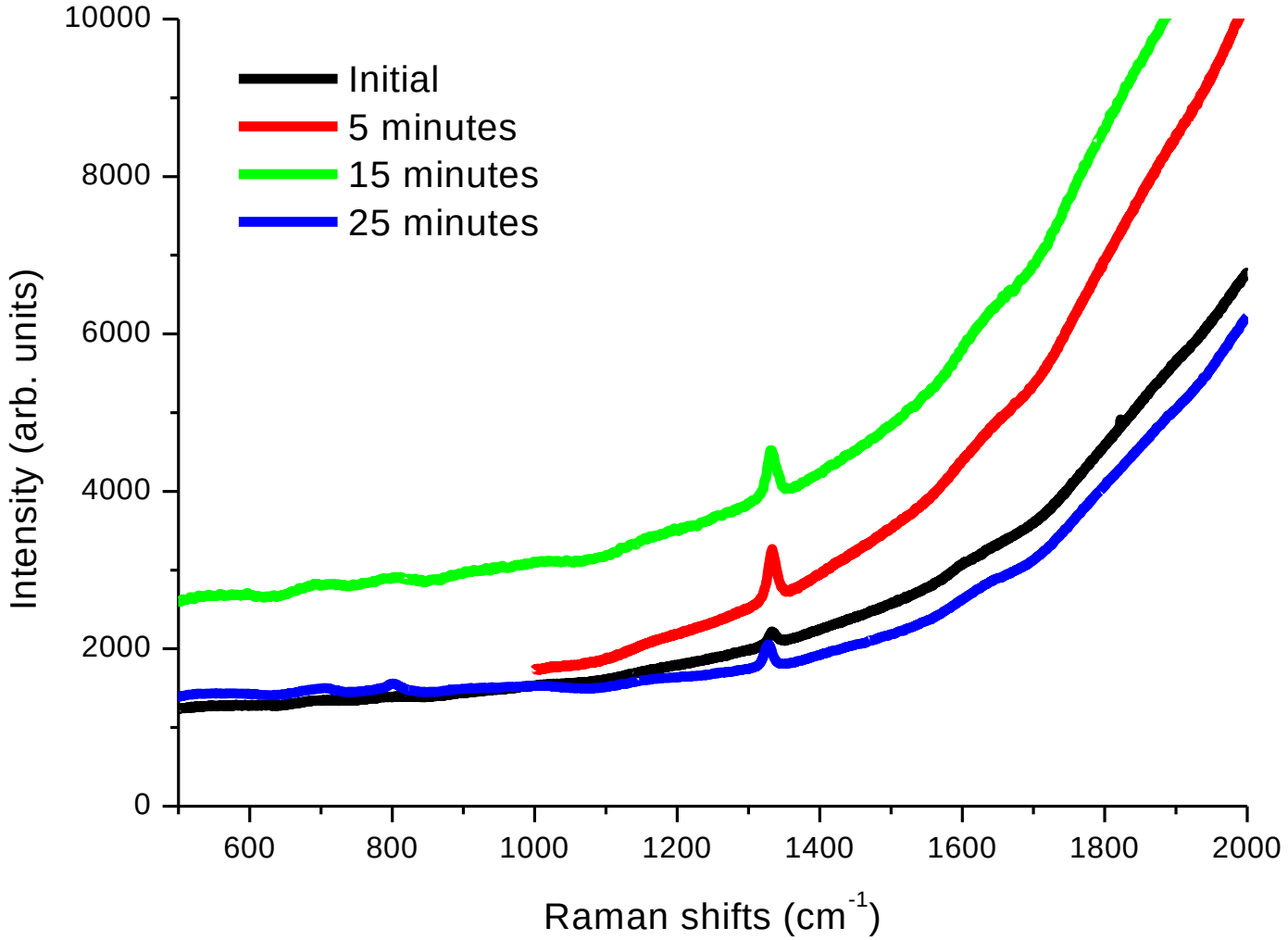




25 min
979 K

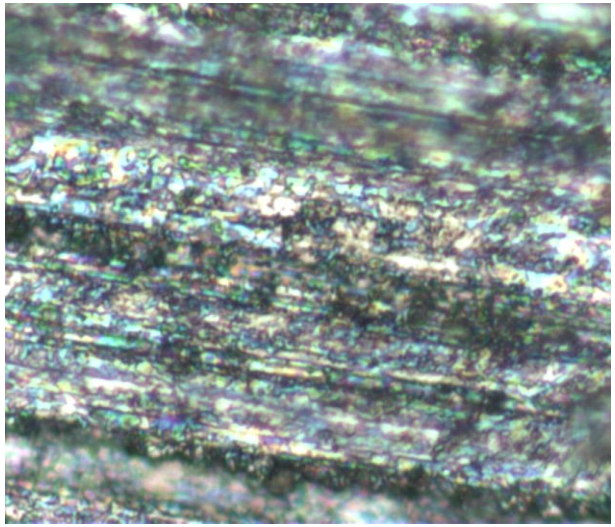
Dark phase is cobalt or tungsten
Grey phase is diamond

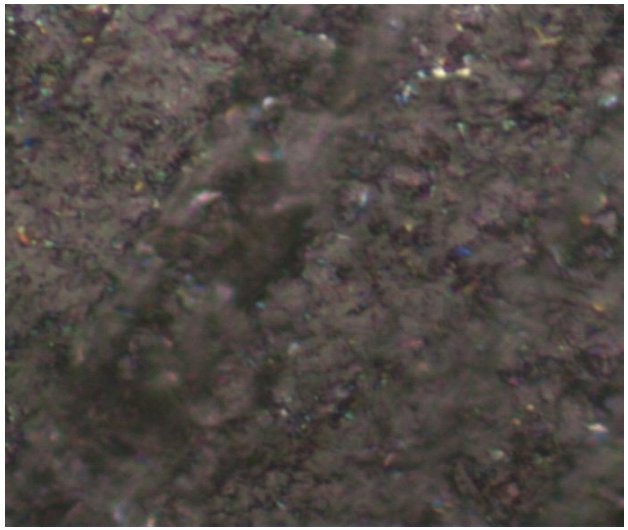
Raman shift at the surface of the PCD layer



Optical images at the surface of the WC-Co layer

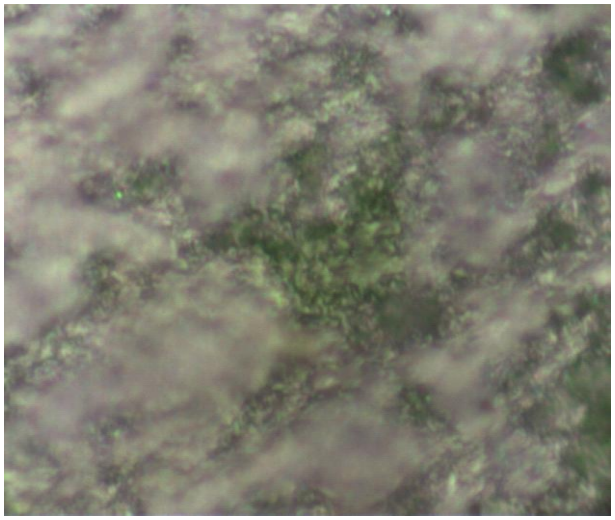
Initial

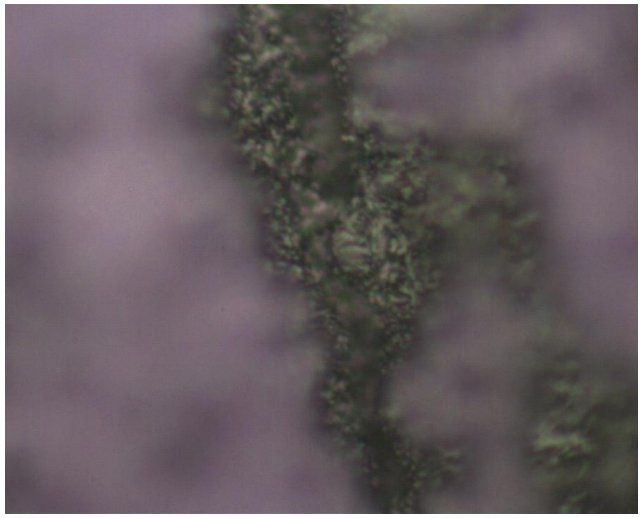




5 min
895 K

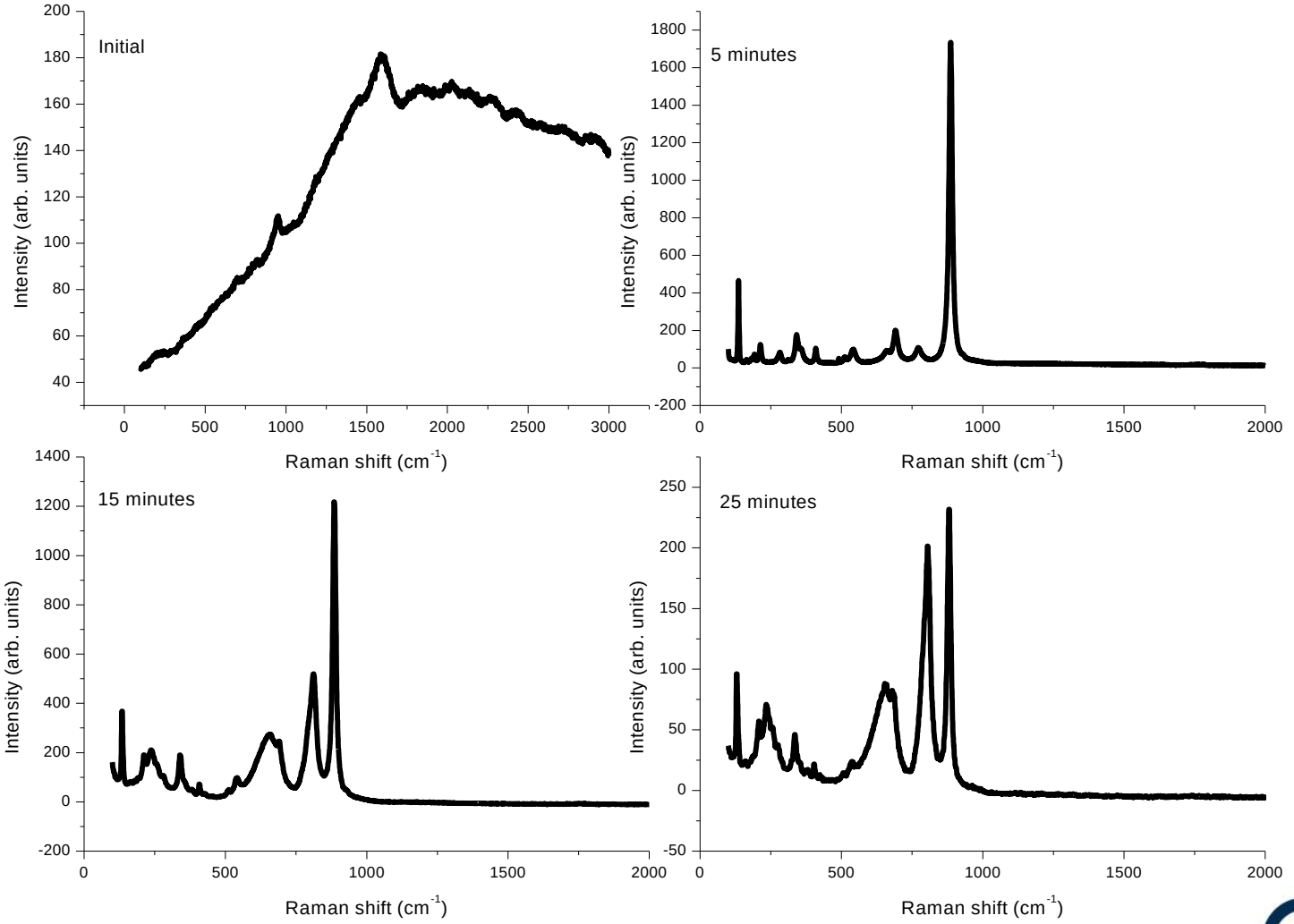
15 min
968 K





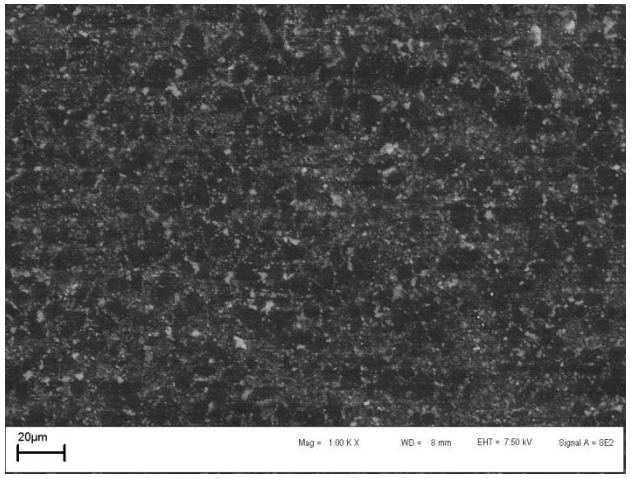
25 min
979 K

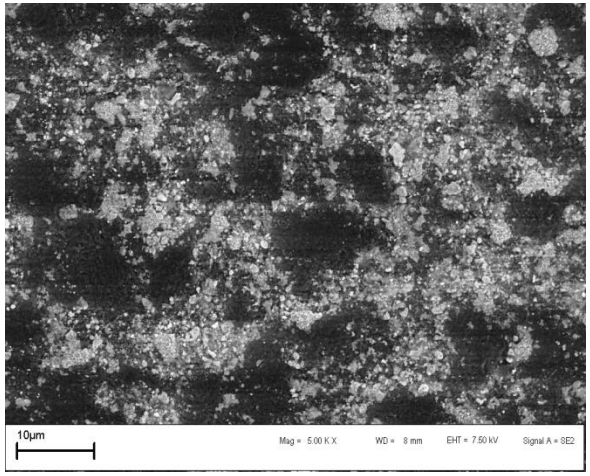
Raman shift at the surface of the WC-Co layer



SEM Micrographs at the surface of the PCD layer

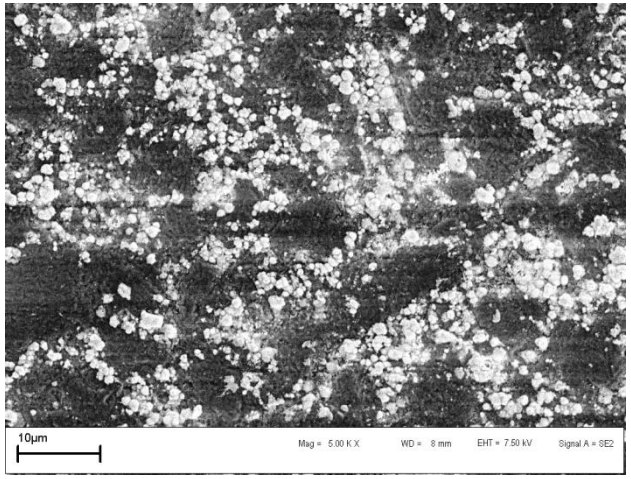
Initial

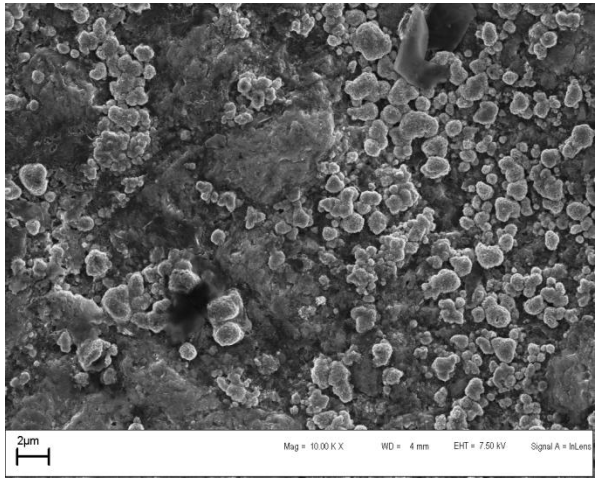




15 min
658 K
26 W
0.7 mm

45 min
681 K
26 W
0.7 mm

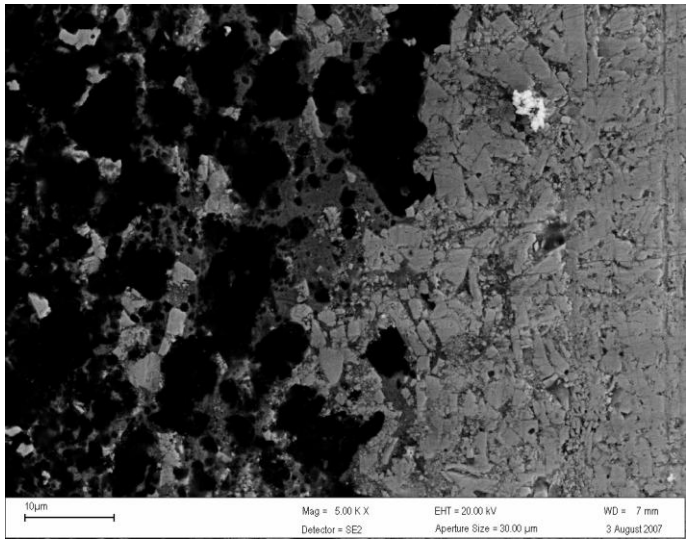


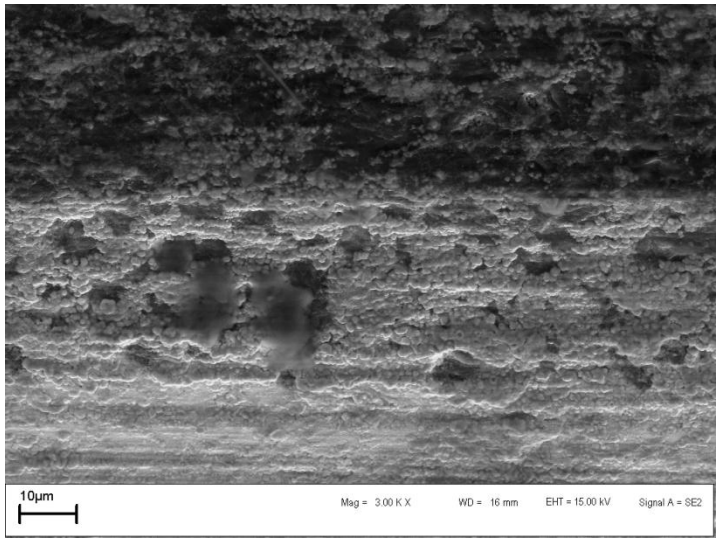


Dark phase is diamond
Grey phase is cobalt or tungsten

SEM Micrographs at the surface of the WC-Co layer

Initial





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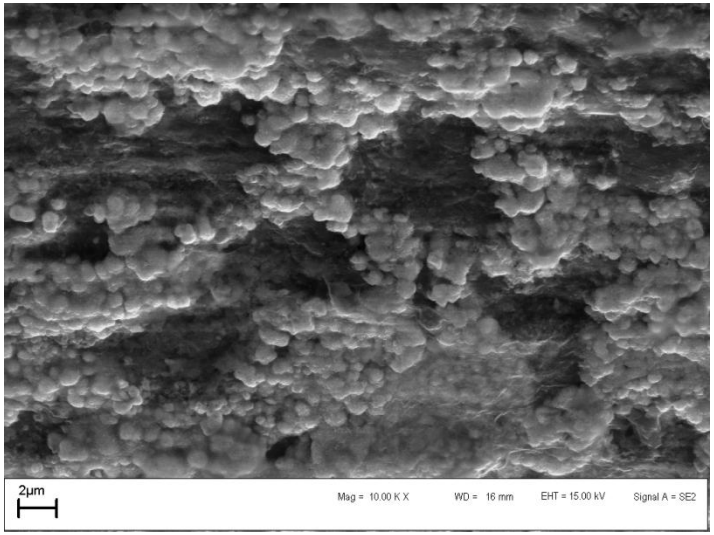

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Conclude remarks

We have successfully raised the temperature of the diamond tool sample and measure it.

We successfully observed the increment of Co and W content on the PCD layer.
We successfully observed the formation of microstructure oxides on the PCD layer.

We show that the temperature in the diamond tool is sufficient to radically alter its physical and chemical properties, resulting in critical fracture.

Thank you