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Application note
Materials sciences

Improving tool bits and ultra-hard coatings using the inVia™ microscope

Manufacturers face many challenges when producing high-quality tool bits. The primary need is to manufacture tools of a consistently high standard.

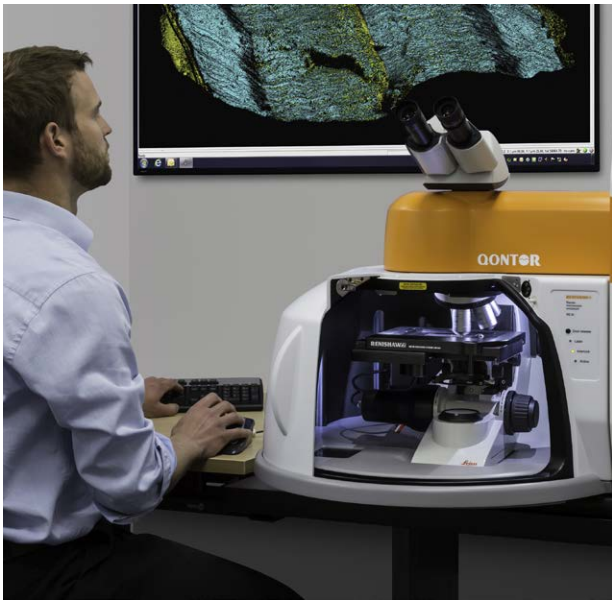
Reproducibility and repeatability are paramount to this process. Therefore, it is essential to understand the effect that the various manufacturing processes have on the resultant tool.

Renishaw's Raman systems can, through changes to the Raman bands, determine the stress and crystallinity of the materials used in tool bits. High resolution Raman images can reveal surface topography and inhomogeneities in chemical composition. This detailed information helps guide the manufacturing process and enables tools to achieve their optimum performance.

Easily identify contaminants

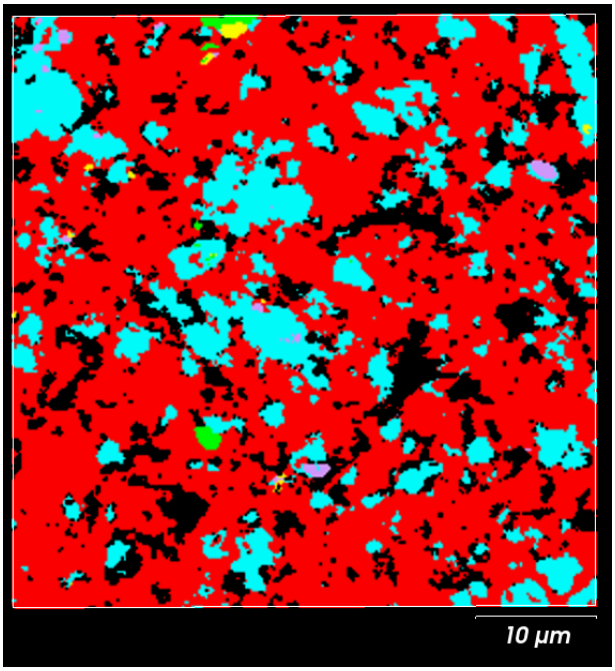
Tool bits need to be made reliably and consistently. For example, small amounts of contaminants can adversely affect quality and tool function.

It is vital to detect these contaminants and determine their effect on performance. This is a challenge that Renishaw's inVia™ confocal Raman microscope can help to overcome.



Analyse the properties of tool bits using Raman spectroscopy

- Renishaw's Raman systems can produce high quality Raman images showing the distribution of contamination across the surface of the tool bit.
- You can rapidly and simply identify unknown materials using dedicated Raman libraries.
- Minute amounts of contaminant can be identified because of the inVia Raman microscope's high spatial resolution.
- You can compare Raman data before and after tool treatment to determine the changes in material quality.



Visualising the distribution of materials in a PCD tool bit

This Raman chemical image of an out of specification polycrystalline diamond (PCD) tool bit (collected using an inVia Raman microscope) shows the presence of a large amount of graphite-like carbon, with smaller quantities of diamond, tungsten carbide and cobalt (II) ferrite.

Renishaw's particle statistics software allows for full statistical analysis of the Raman chemical image. This demonstrated that, for this tool, the surface area of tungsten carbide accounted for 0.11% of the total area.

- Graphite-like carbon
- Diamond
- Tungsten carbide
- Cobalt (II) ferrite

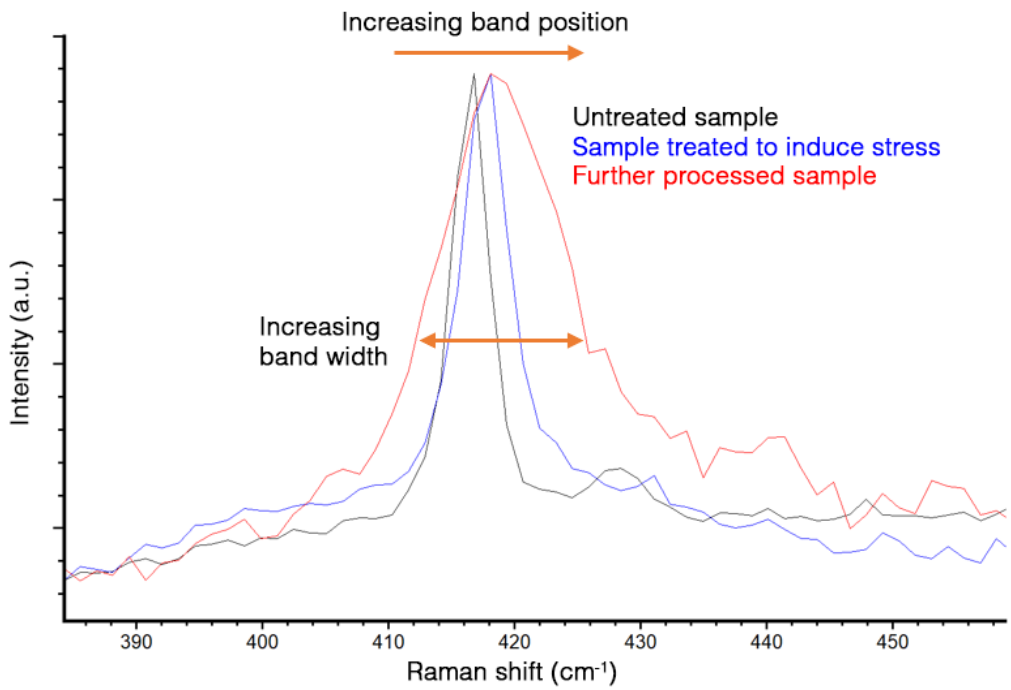
Monitoring stress and crystallinity

The presence of compressive stress in tool coatings can enhance tool properties, such as the hardness and flexural strength. In contrast, tensile stress can have a detrimental effect on tool performance.

Renishaw's Raman systems can distinguish between different types of stress in samples. Their ease of use and rapid data collection makes analysis of stress easy.

Benefits of Raman spectroscopy

- Identify the direction of stress present in tool coatings through simple monitoring of Raman band shifts.
- Investigate the effect of treatments and manufacturing processes on the intrinsic properties and quality of the sample.
- Establish material crystallinity using the width of the Raman band.
- Reveal the relationship between surface topography and stress using 3D Raman images.



Analysing the results

Raman spectra of Al_2O_3 showing the band shift for areas of the sample subjected to a stress-inducing treatment process. The shift represents a change in the stress of the sample at that point. The direction of band shift indicates this is compressive stress. The increase in stress correlates with an increase in band width. This may be attributable to a reduction in material crystallinity.

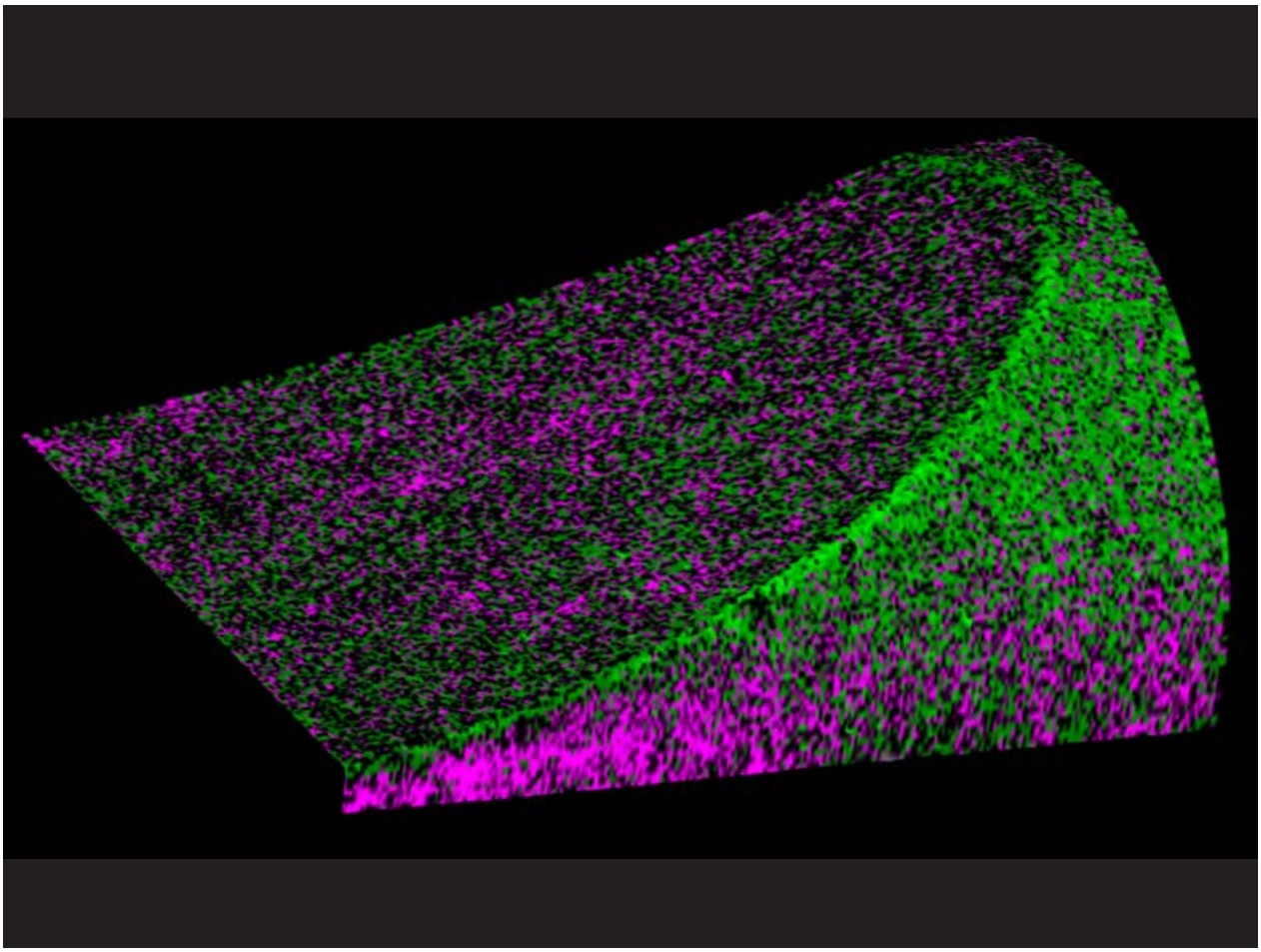
Mapping the complex surfaces of tool bits

It can be challenging to collect high quality in-focus Raman data from the complex geometry of tool bit surfaces. It can also be hard to collect data from large tool bits, where the variation in surface height can be several centimetres.

With Renishaw's LiveTrack™ focus tracking technology, this is no longer an issue. LiveTrack technology maintains optimal focus across the surface of tool bits, even large ones and those with complex topographies.

Benefits of LiveTrack technology

- Dynamically map uneven sample surfaces without the need for sample preparation or pre-scanning.
- Obtain topography information from samples with micrometer-sized defects to large samples several centimetres across.
- Reveal the effect of topographic variations on sample properties, such as chemical composition and stress.



TiO_2 TiN

Maintaining focus with LiveTrack technology

LiveTrack technology was used to create this 3D Raman image of a tool bit from a consumer grade screwdriver head (8.1 mm × 5.1 mm × 3.6 mm). Optimal focus was maintained across the entire surface during data collection.

The 3D image shows the distribution of TiN and TiO_2 over the complex surface.

The inVia Raman microscope is ideal for characterising tool bit coatings

- It is not only a confocal Raman microscope but also a research-grade optical microscope.
- It offers non-contact and non-destructive material analysis.
- Materials can be quickly and easily identified with Renishaw's material libraries.
- Sub-micrometre, high spatial resolution Raman imaging.
- In-built tools to characterise material properties and generate spatial images.
- Live measurement of surface topography with Livetrack automatic focus-tracking.

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