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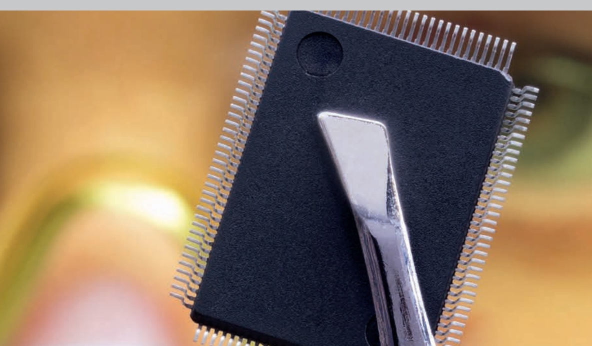
Analyse silicon carbide (SiC) with the inVia Raman microscope



Materials science

Silicon carbide has significant advantages over silicon, such as a wider band gap, higher thermal conductivity, and higher breakdown field. It is also chemically and thermally inert. These properties make it attractive for use in transistors (JFETS, MOSFETs, etc.) in applications such as high temperature electronics, and in fast high voltage devices for more efficient power transmission and high temperature operation. It is being used in a new generation of power electronics for transportation systems.

Challenges facing silicon carbide

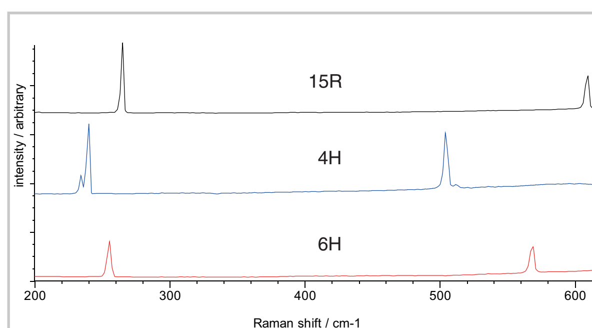
The properties of silicon carbide are highly dependent on its crystal structure (it can exist in many polytypes), on the quality of the crystal, and on the number and types of defects present. Manufacturers of silicon carbide raw material and devices need to monitor and control these attributes to enhance yield.

The power of Raman spectroscopy

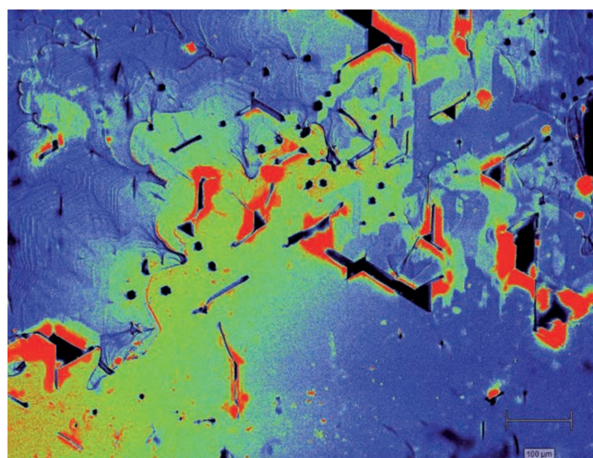
The first step in controlling these parameters is to measure them repeatably and quantifiably. Renishaw's Raman systems are ideal for this. Analysing laser light scattered from the silicon carbide enables determination of crystal form, quality, and the nature of defects. You can do this easily, rapidly, and non-destructively. The analysis can be of a tiny region or a whole wafer and can reveal surface, and subsurface, information in three dimensions.

Renishaw's Raman systems can:

- Determine the crystal polymorphs and polytypes present
- Reveal their distribution
- Measure stress/strain
- Determine electronic properties, such as free carrier concentration and dopant levels
- Map large wafers rapidly
- Analyse the complex defects in three dimensions
- Study depth profiles, interfaces, and layers
- Be used for both development and as QA, FA tools



Determine which polymorphs and polytypes are present - Raman spectra clearly differentiate 15R, 4H, and 6H, allowing for detailed high resolution identification and mapping.



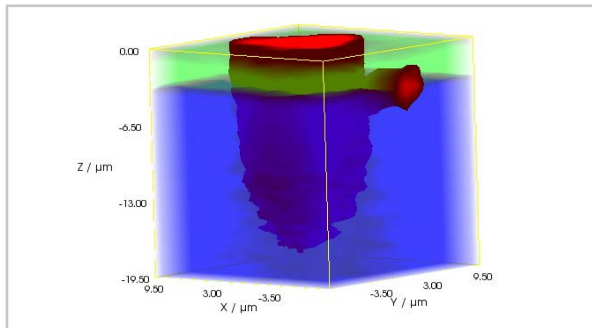
Large wafers in high definition - Approximately 1 mm square Raman image showing inclusions of 6H-Silicon carbide, 3C-Silicon carbide or Si (red), voids (black), and strain distribution (blue to green).

Renishaw plc

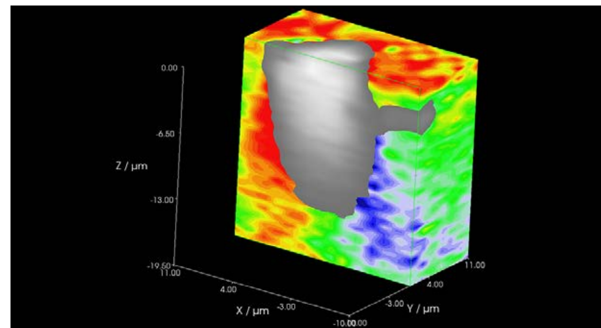
Spectroscopy Products Division
New Mills, Wotton-under-Edge,
Gloucestershire GL12 8JR
United Kingdom

T +44 (0) 1453 524524
F +44 (0) 1453 524901
E raman@renishaw.com

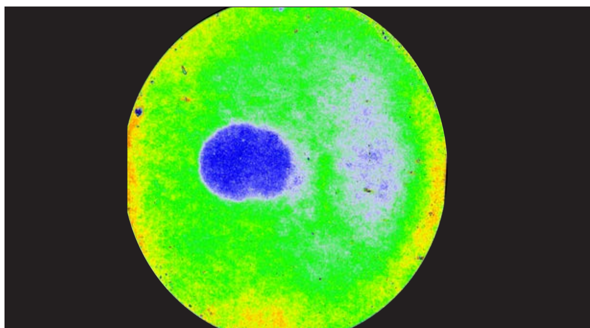
www.renishaw.com/raman



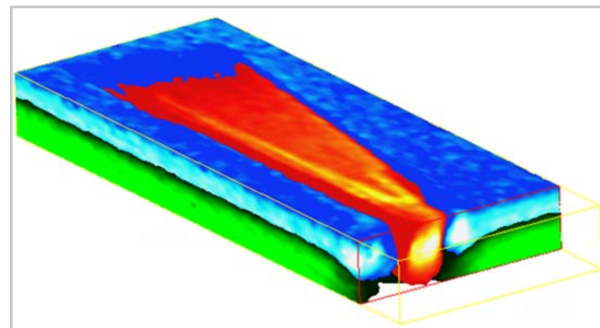
See subsurface features - 3D Raman image of core inclusion, showing: 3C-SiC inclusion (red); 4H-SiC epilayer (green); doped 4H-SiC substrate (blue). Sample courtesy of Prof. Noboru Ohtani, Kwansei Gakuin University, Japan.



Stress regions surrounding the defect (grey) and 4H/3C boundary. Compressive stresses (red), tensile stresses (blue)



Fast results - whole 2 inch wafer of silicon carbide scanned in less than 30 minutes. The Raman image highlights non-uniformity, such as variations in doping level and the presence of defects such as other polytypes and foreign material.



See defects in high detail - 'comet' defect, showing doped 4H-SiC substrate (green), 4H-SiC epilayer (blue), and 3C-SiC inclusion (red/ orange). The mapped region is 70 × 25 × 7 µm³.

inVia. The ideal Raman imaging tool

- Research grade Raman microscope
- StreamLine™ imaging technology for high speed mapping, including whole wafers
- Surface option to obtain the best images from uneven surfaces
- StreamLine imaging with Slalom for a quick overview of the samples
- High confocality StreamHR™ imaging to scrutinise small details
- Flexibility to switch between high and standard confocal imaging
- Queue up measurements to maximise data collection

The Renishaw inVia Raman microscope

Renishaw. The Raman innovators

Renishaw manufactures a wide range of high performance optical spectroscopy products, including confocal Raman microscopes with high speed chemical imaging technology, compact process monitoring Raman spectrometers, structural and chemical analysers for scanning electron microscopes, solid state lasers for spectroscopy and state-of-the-art cooled CCD detectors, for both end-user and OEM applications.

Offering the highest levels of flexibility, sensitivity and reliability, across a diverse range of fields and applications, the instruments can be tailored to your needs, so you can tackle even the most challenging analytical problems with confidence.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

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