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Analyse coatings with the inVia™ confocal Raman microscope

Chemical sciences

Chemically characterise your coatings with Renishaw's inVia confocal Raman microscope. It is the ultimate system for studies ranging from fundamental research on the materials involved through to final product quality control and failure analysis.

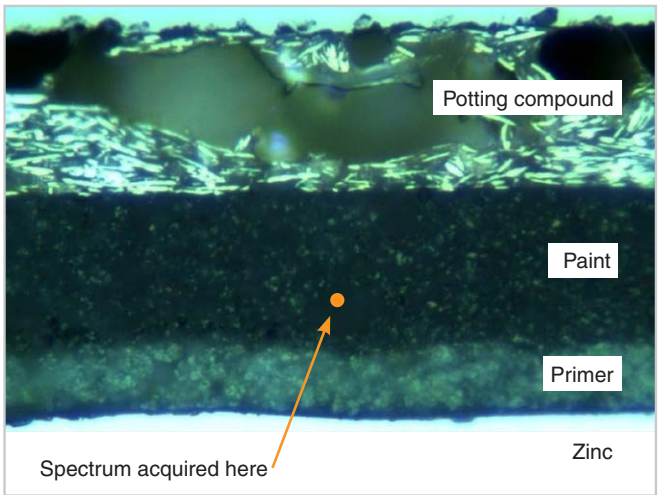
The inVia confocal Raman microscope is an ideal tool for studying coatings.

- Provides unambiguous identification of all material types of interest:
  - organic and inorganic
  - crystalline and amorphous
  - solids (including polytype/allotrope differentiation) and liquids
- Gives information on the spatial distribution of material, via depth profiles and 2D and 3D maps, and can resolve sub-micrometre features
- Use for *ex situ* and *in situ* measurements
- Can map curved, uneven and rough surfaces
- Automatically maintain focus and get good data from coatings as they expand/contract during curing and interaction with the environment
- Uses a non-destructive, non-contacting technique
- Polymer and inorganic material (and other) spectral databases available
- Results can be quantified with metrics, such as fraction estimates and particle statistics
- Analyse unknown materials with powerful multivariate statistical algorithms

Coatings on steel

inVia can be used on a very wide range of paints and coatings. This example illustrates its use to study coatings applied to zinc-coated steel.

The sample consisted of primer (approximately 10 µm) and paint (approximately 20 µm) layers applied to zinc. The sample was sectioned by ion-beam milling prior to analysis by inVia. Particles could be seen within the paint layer.

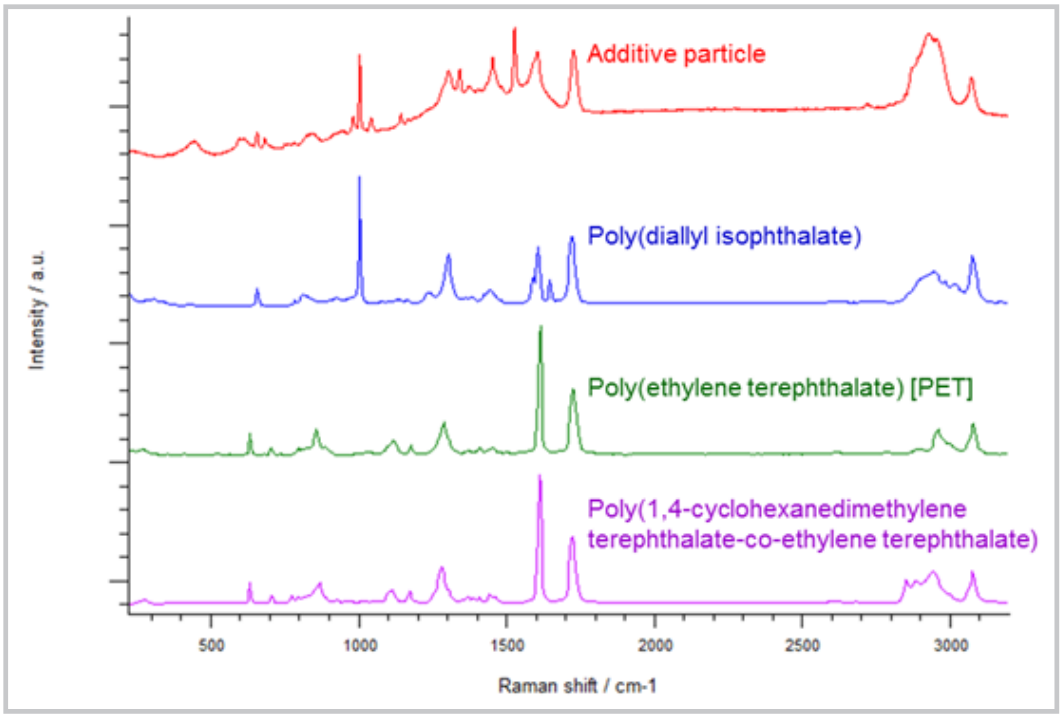


Optical micrograph of the sample. The orange dot indicates the location of the particle that was analysed.

Analysis of a particle within the paint layer

Particles are visible in the optical micrograph, within the paint layer. One of them was analysed with a Raman point measurement. Due to the high confocality of the inVia, the resulting spectrum was predominantly from the additive, without significant contributions from the surrounding paint.

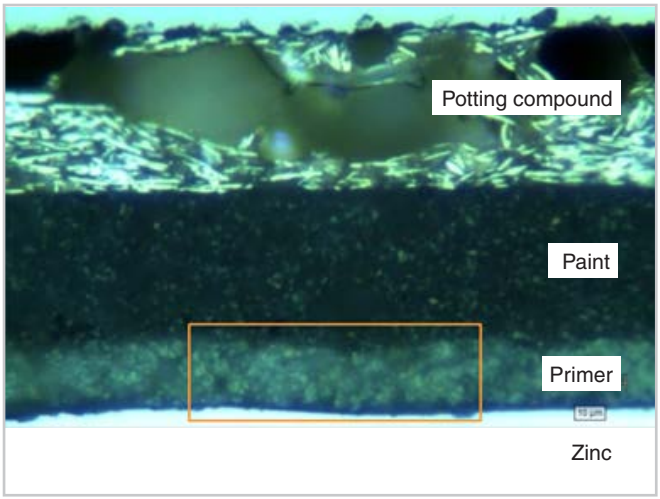
The spectrum was compared with entries from the Renishaw spectral database of polymers and was found to most closely match phthalates, in particular poly(diallyl isophthalate), DAIP, a common plasticizer.



Comparison of the spectrum of the particle against the top three matching spectra from the Renishaw spectral database of polymers.

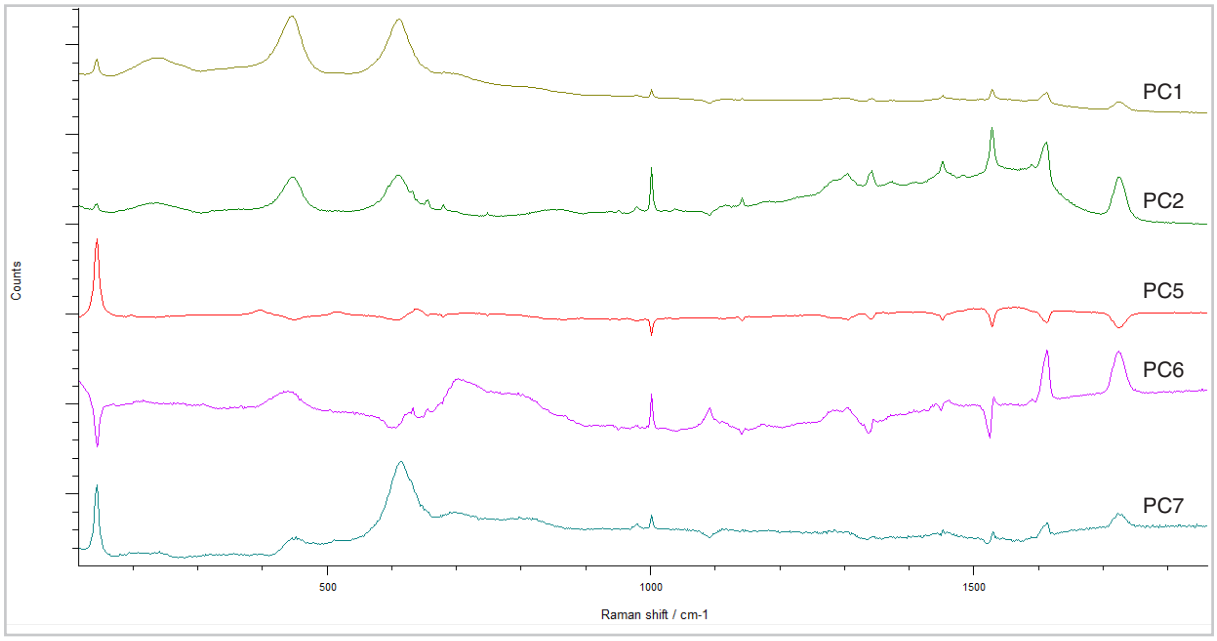
Chemical mapping of the primer

The components of the primer layer were also analysed. A region 12 µm × 40 µm was mapped using a 0.2 µm step size.



The region analysed by Raman mapping. The orange box indicates the region 12 µm × 40 µm that was mapped at 0.2 µm step size.

The map was analysed using principle component analysis, where the data are automatically decomposed into distinct components.

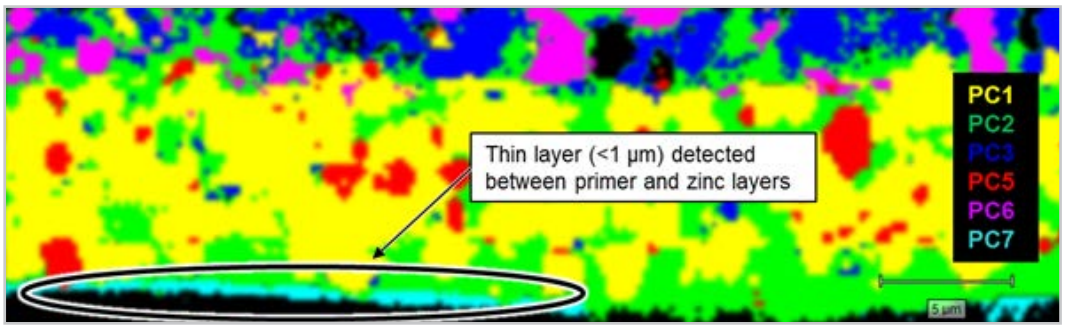


Principle component analysis of the mapped primer region. PC1 is the first component (the most significant), PC7 the least significant.

The principle components were identified as follows:

Component	Colour coding	Identification
PC1	Yellow	TiO_2 (rutile)
PC2	Green	Phthalate polymer
PC5	Red	TiO_2 (anatase)
PC6	Magenta	Phthalate polymer
PC7	Cyan	Carbonate

An image was then produced, with the components coded by colour. The image reveals the distribution of materials, and can be compared with features visible in the optical micrograph. This image suggests that the phthalate polymer (magenta) is mainly present in the paint layer, whereas the other phthalate polymer (green) is present in both primer and paint. The TiO_2 (yellow/red) is mainly present in the primer. The carbonate (cyan) is located at the interface between the metal and the primer; it is probably zinc carbonate ($ZnCO_3$). This thin layer (less than 0.5 µm) was only detectable because of inVia's high sensitivity and high spatial resolution.



Raman image of the primer layer. Principal component 7 corresponds to a thin layer between the primer and zinc coating (visible inside the black oval).

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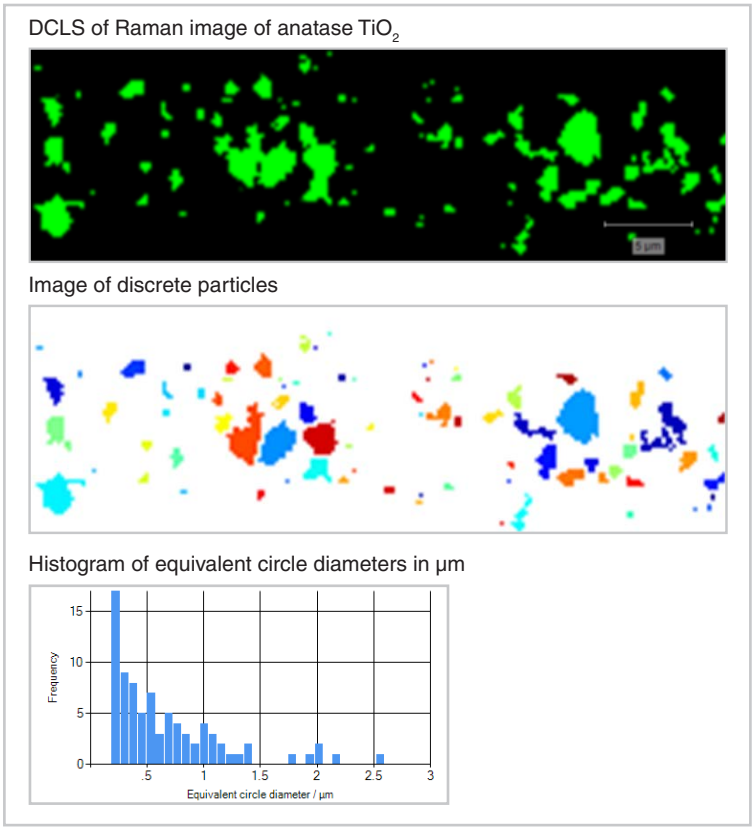
Particle size statistics

inVia's WiRE software (Windows-based Raman Environment) has extensive particle statistics capabilities. This was used to analyse the anatase TiO_2 in the primer. Direct classical least squares (DCLS) was used to generate a binarised image, giving the location of the anatase. The particles were then identified and size analysis performed. This indicated a relatively small particle size, with a mean equivalent circle diameter of 0.9 µm.



Particle size analysis of the anatase in the primer. The image of the location of the anatase (top) is resolved into discrete particles (middle). These are then used to generate a histogram of size (bottom).

inVia is the comprehensive analysis tool:

These results illustrate the ease with which you can use Renishaw's inVia confocal Raman microscope to study paints and coatings.

inVia. The ideal coating analysis tool

- Research grade Raman microscope
- High sensitivity to detect traces of material
- High spatial resolution to scrutinise small details
- A range of rapid mapping and imaging solutions that can map curved, uneven and rough surfaces
- Polymer and inorganic material (and other) spectral databases available
- Results can be quantified with metrics, such as fraction estimates and particle statistics

The Renishaw inVia confocal Raman microscope

A range of related Renishaw literature is available. Please ask your local Renishaw representative for more information.

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.

Please visit www.renishaw.com/chemicals for more information.