WiRE™ software: automatic cosmic ray removal

Remove unwanted cosmic ray artefacts automatically

Renishaw's Raman systems have unparalleled sensitivity, allowing you to measure Raman scattering from the weakest samples. As a consequence, these systems are also excellent at measuring cosmic ray events. Cosmic rays (CRs) are high-energy particles which originate from outside the Earth's atmosphere. They usually result from solar activity but can come from other events outside our galaxy such as supernovae.

They can create artefacts in our Raman data (Figure 1) by randomly impacting the detector during Raman data collection. When we collect Raman images or map data over long durations, these ray events may become problematic and may number in the thousands. Renishaw's propriety WiRE™ software can automatically and quickly remove any artefacts caused by cosmic rays to ensure you have the best quality data for your analysis.

Automatic cosmic ray removal in WiRE software

WiRE* software includes an automatic, post-data collection tool that provides accurate cosmic ray removal (CRR). The method is fast and targeted, so it can quickly remove many spurious features from spectra. In addition, it can be applied to very large files (up to 50 million spectra) where manual alternatives are extremely laborious or even totally impractical.
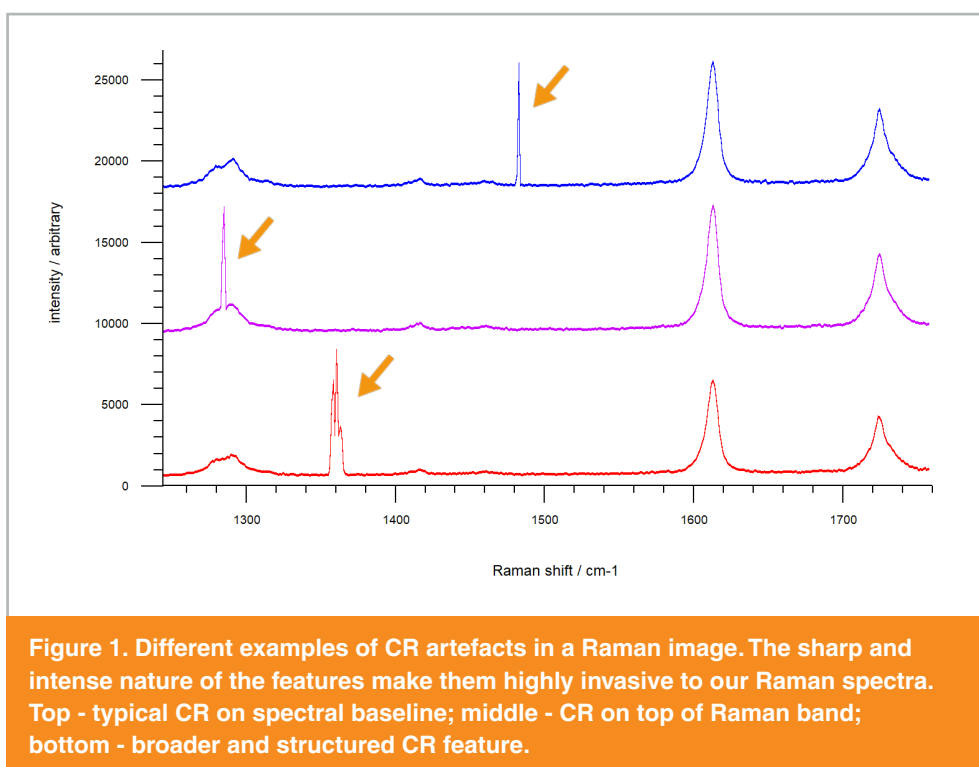
The automatic CRR software feature finds CR candidates by combining the nearest neighbour and width of feature method. Then, it uses auto-reject parameters to intelligently categorise them as possible CR or non-CR features (e.g. Raman bands). This ensures that the features being removed from the data correspond to real CRs.

Why do we need to remove cosmic rays?

When not correctly removed from your data, these unwanted features can:

- hide the true chemical or physical information

- cause errors during data processing and analysis, particularly when using multivariate chemometric methods which use the entire spectrum

- alter spectral band shape, leading to misinterpretation

- impact the quality of Raman images, making them less representative and attractive

When analysing or interpreting Raman data it is essential we remove CR artefacts without affecting the real spectral features.
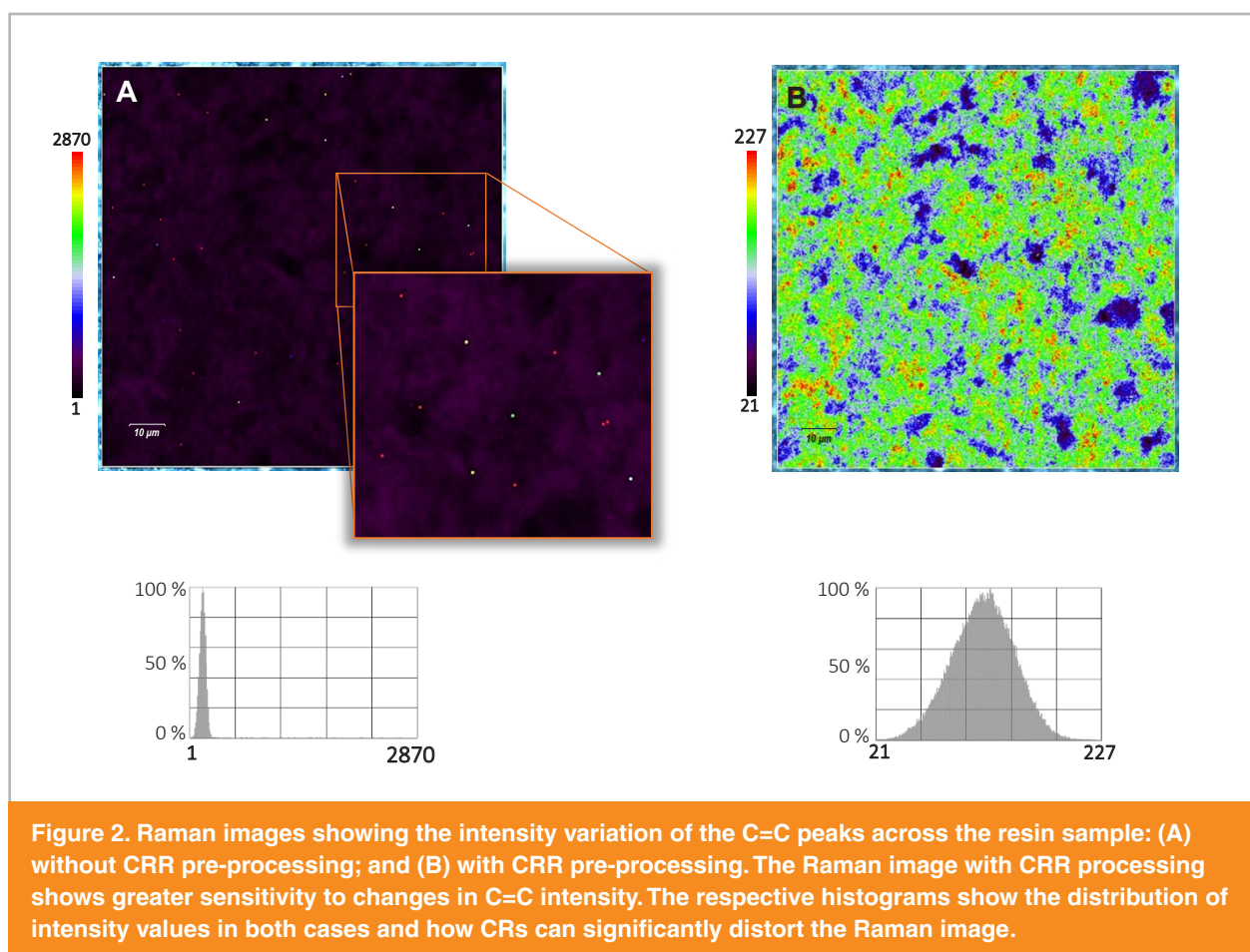

Figure 1. Different examples of CR artefacts in a Raman image. The sharp and intense nature of the features make them highly invasive to our Raman spectra. Top - typical CR on spectral baseline; middle - CR on top of Raman band; bottom - broader and structured CR feature.

*WiRE 5.6 versions and later

Make Raman images more accurate

Here we show the benefit of removing CR features to produce accurate and interpretable results. Raman images were generated from the analysis of 111,000 spectra. The C=C Raman band intensity was analysed to determine the degree of conversion of a resin. This is an important parameter which affects the adhesion, friction and wettability properties of the material.

Figure 2A shows how the CR features dominate the results. These outliers dramatically change the image which is produced by skewing the way the colours correlate to the intensity values (the histogram).

Figure 2B shows how removing the CR features produces accurate results in an image with no outliers or artefacts. As well as improving the visual appearance, any quantitative analysis will now be representative of the real data.

Figure 2. Raman images showing the intensity variation of the C=C peaks across the resin sample: (A) without CRR pre-processing; and (B) with CRR pre-processing. The Raman image with CRR processing shows greater sensitivity to changes in C=C intensity. The respective histograms show the distribution of intensity values in both cases and how CRs can significantly distort the Raman image.

Quickly see your true Raman results

WiRE software's cosmic ray processing methods are a robust way to accurately eliminate unwanted features in Raman spectra, even in very large Raman images. Use the automatic CRR for a simple, fast and completely automated workflow to ensure your data are free from CRs.

When performance really matters, choose Renishaw

We launched our first Raman spectroscopy product in 1992, and have been continuously developing Raman instrumentation ever since. Decades of experience ensure that our products can be trusted to deliver the results you need. Our Raman systems are built with parts manufactured in-house. These are put through extensive and rigorous testing to ensure they are highly stable and reliable.

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