

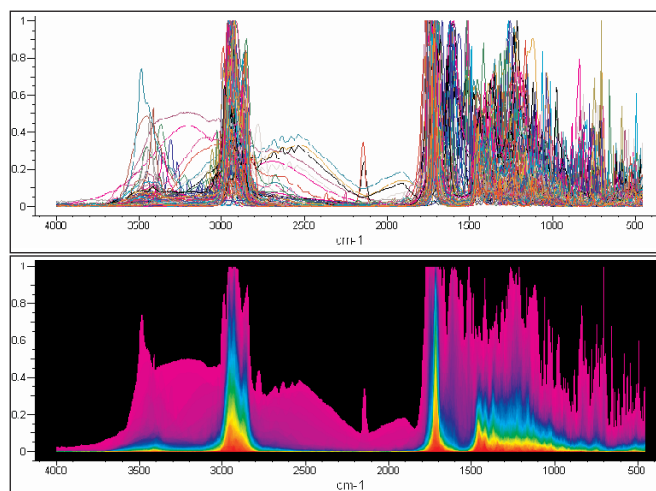
Overlap Density Heatmaps

Patent Pending Technology

Bio-Rad's Informatics Division has introduced this new breakthrough technology for visual datamining and analysis to assess the similarities and dissimilarities in massive amounts of spectral, chromatographic, or other graphical data. This patent pending technology, called Overlap Density (OD) Heatmaps and OD Consensus Object displays, will allow scientists to visualize easily the common features of the overlapped objects (such as spectra or chromatograms) by color coding the areas from highest to lowest overlap.

This technology can be used to analyze the large amounts of graphical data from such disciplines as cheminformatics, analytical informatics, metabolomics, chemometrics, genomics, and/or proteomics and has applicability in all branches of scientific research, including chemistry, the life sciences, and diagnostics. It can also be used with any analytical or chromatographic technique, including IR, NMR, MS, and Raman.

“Can't see the forest for the trees” is a problem inherent in the traditional stacked display of spectra or chromatograms: the information content diminishes as more objects are stacked. Overlap Density Heatmaps reverse this situation by allowing the comparative visualization of the overlap of vast numbers of spectra or chromatograms.



The OD Scale

An arbitrary scale was created to define the extent of overlap for the objects being compared and displayed:

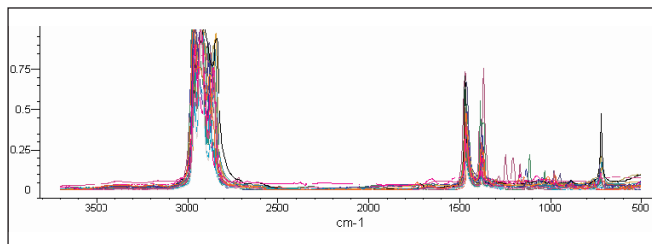
- OD Level = 0: **ALL** - Shows all levels of object overlap.
- OD Level = 100: **COMMON** - Shows only the areas of highest overlap.
- OD Level = -100: **UNIQUE** - Shows only the areas of lowest overlap.

Overlap Density Examples

Traditionally, the visualization of multiple spectra or chromatograms takes place in an overlay, offset, or stacked plot. These plotting methods obliterate trends when viewing large amounts of data. The OD Heatmap and OD Consensus Spectrum technologies allow trends to be viewed with ease, turning heretofore unmanageable amounts of *data* into *actionable information*—information upon which decisions can be made. The examples on the following pages show the basic principles of OD Heatmaps and OD Consensus Spectra starting with a dataset of the IR spectra of twenty five alkanes.

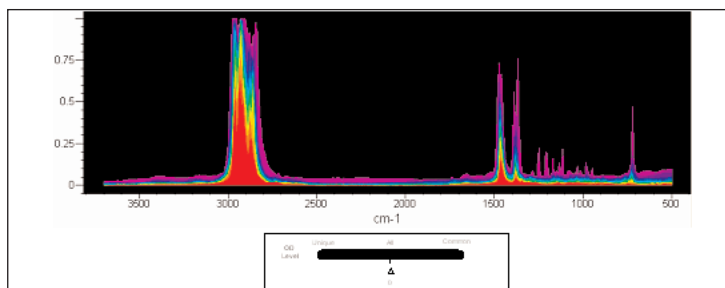
Traditional Stacked Spectra Display

Twenty-five IR spectra of normal alkanes are shown. While some trends appear, the extent of the trends is obscured.



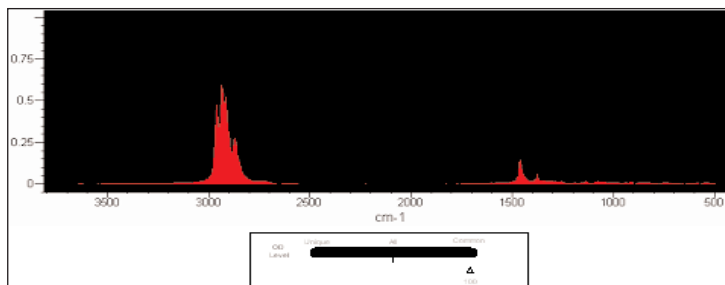
OD Heatmap OD Level = 0

An Overlap Density Heatmap of the fourteen normal alkanes shown revealing all overlap levels. High levels of overlap are displayed in red; low levels are displayed in violet.



OD Heatmap OD Level = 100

An Overlap Density Heatmap showing only those areas of overlap common to all spectra.



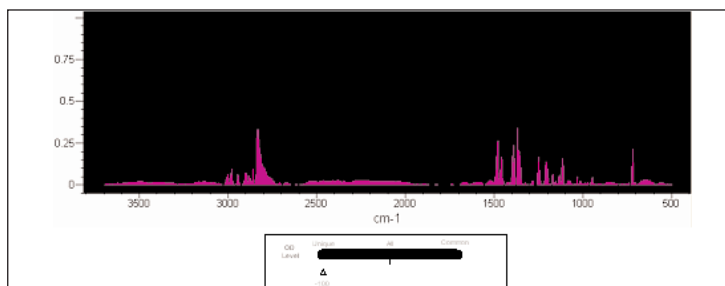
Controlling the Overlap Displayed: The OD Level Slider

The OD level can be changed with a single slider control to change the overlap density displayed in the OD Heatmap: an OD Level = 0 will show all colors representing all overlap density levels; an OD level of 100 will show only red representing only those areas where 100% of the spectra share areas in common; and an OD level of -100 will show only violet areas representing only those areas where one spectrum exists but no other spectra overlap in the same area. Values in between display intermediate ranges of overlap.

The Overlap Density Heatmap and Overlap Density Consensus displays can be used in most KnowItAll® applications where spectra are displayed.

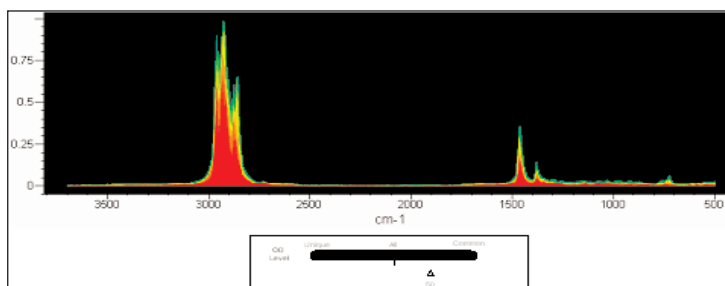
OD Heatmap OD Level = - 100

An Overlap Density Heatmap showing only those spectral areas of that are unique, that is, those that do not overlap with any other spectra.



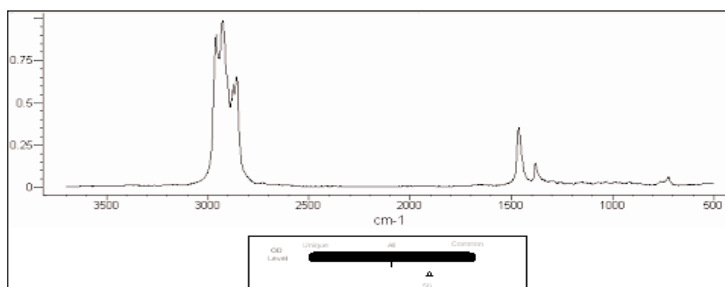
OD Heatmap OD Level = 50

An Overlap Density Heatmap showing only those areas of overlap common to all spectra.



OD Consensus Spectrum OD Level = 50

An Overlap Density Consensus Spectrum showing a mathematically reconstructed spectrum created from the maximum spectral Y-values at each spectral X-value in the OD Heatmap shown above.



Overlap Density Consensus Spectra or Chromatograms

An Overlap Density Heatmap is a useful tool for determining areas of high, low, or intermediate overlap density in a number of overlapped spectra, chromatograms, or other objects. By tracing the outline of the highest level of overlap at a given OD level, however, it is possible to mathematically reconstruct a spectrum by using the maximum spectral Y-values at each spectral X-value in the OD Heatmap. This Overlap Density Consensus Spectrum can then in turn be used as the spectrum in a spectral search query to find similar spectra in user or reference databases as an entry to be stored in a database for future reference, or for reporting.

Quantifying the Results of OD Heatmaps

Several numerical values have been defined to allow for consistent and objective quantification of the results of OD Heatmap and OD Consensus Spectrum studies:

%AUC_x The percentage of the total area under the curve at OD level x relative to total area under the curve at OD level 0 (ALL, or the center of the OD scale), that is, %AUC₀ = 100.

ODC_n OD Level (on COMMON side of scale) required to display n% of total overlap area.

ODU_n OD Level (on UNIQUE side of scale) required to display n% of total overlap area.

%AUC_x + %AUC_{-x} = 100 for any given values of x and -x.

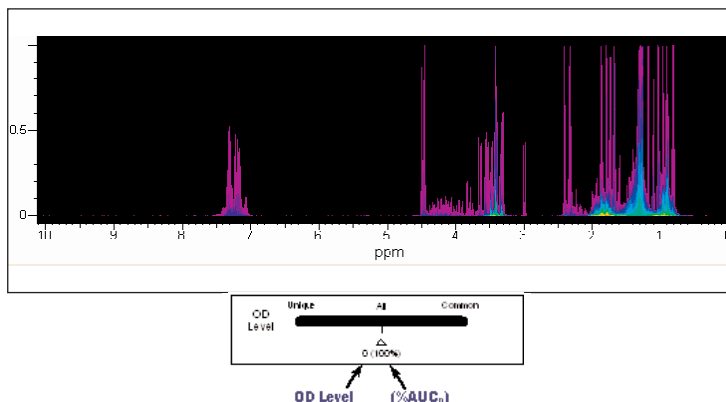
ODC_n - ODU_n = 100 for any given OD value of n.

ODC₁₀₀ = 0

The OD level on the "COMMON" side of the OD scale required to display 100% of the area under the curve is 0.

%AUC₀ = 100%

The percent area under the curve at OD level 0 relative to the area under the curve at the reference point (OD level 0) is 100% by definition.

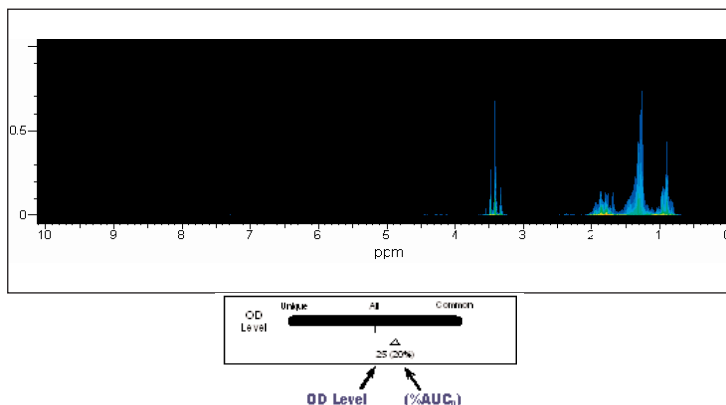


ODC₂₀ = 25

The OD level on the "COMMON" side of the OD scale required to display 20% of the area under the curve is 25.

%AUC₂₅ = 20%

The percent area under the curve at OD level 25 relative to the area under the curve at the reference point (OD level 0) is 20%.



BIO-RAD

**Bio-Rad
Laboratories**

Informatics Division
www.knowitall.com

U.S. Sales Phone: +1 215 382 7800 • 1 888 5 BIO-RAD (888-524-6723) • E-mail: informatics.usa@bio-rad.com
Europe Phone: +44 20 8328 2555 • E-mail: informatics.europe@bio-rad.com
Japan Phone: +81 03 (5811) 6287 • E-mail: informatics.nbr@bio-rad.com
Rest of World Phone: +1 215 382 7800 • E-mail: informatics.row@bio-rad.com