INFRARED MICROSCOPY AT THE SYNCHROTRON ANKA: APPLICATION TO THE STUDY OF FLUID INCLUSIONS

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ANKA is a new synchrotron radiation facility at the Forschungszentrum Karlsruhe, a large government research center in the southwest of Germany. The acronym stands for Angstrom Source Karlsruhe. The electron storage ring has been in operation since September 2000 and is now running routinely at 2.5 GeV beam energy and 200 mA current.

The infrared beamline ANKA-IR uses a bending magnet edge as a source and covers a spectral range from 4 to 10000 cm^{-1} (0.5 meV – 1.24 eV; 2.5 mm – 1 μm). Its end is coupled with two experimental stations centered around two Bruker IFS66v/s spectrometers. One of them was provided by the German federal government as part of the Synchrotron Environmental Laboratory (SUL) project. It is equipped with an infrared microscope (Bruker IrscopeII) covering the mid- and near-IR ranges. Set-ups for studies at low/high temperatures as well as at high pressure are under construction.

Synchrotron radiation in the infrared spectral range provides a number of key advantages compared to conventional thermal sources for infrared spectroscopy, e.g.:

(i) The brilliance (photon flux per unit area per unit solid angle per 0.1% bandwidth) is up to three orders of magnitude greater over the entire spectral range. This leads in particular to a vast improvement in signal-to-noise ratio when recording the infrared spectra of microscopic samples at high spatial resolution;

(ii) The entire spectral range from the near infrared to the far infrared can be covered without having to switch light sources.

High brilliance is desirable for any measurement with a limited "throughput", meaning a small sample area of few micron range. Perhaps one of the best examples of the use of high-brilliant, broadband IR light is micro-spectroscopy, which is expected to be a growing field for the characterization of different parts of small sized fluid inclusions on scales comparable to Raman measurements, and the synchrotron source is well-suited to this technique (Guilhaumou et al., 1998). Compared to the spatial resolution achieved by micro-Raman spectroscopy the spatial resolution, which can be achieved by infrared micro-spectroscopy, is diffraction limited and of the order of a few tens of micrometers. Using a conventional infrared thermal source, the resolution cannot be made as low as the diffraction limit would. This is because of the lack of energy at the sample position when measuring samples smaller than 20 micrometers.

There are number of areas where fluid inclusion studies can be applied to geological problems. One example is diagenesis linked to oil input for reservoir exploration. However, comparatively little work has been carried out to date, partly because of the small size (<10 μm) of most components in inclusions of interest.

In this presentation we will discuss synchrotron FTIR in situ microanalysis at a micrometer scale of components of hydrocarbon bearing fluid inclusions entrapped in diagenetic minerals as calcite, quartz and fluorite in near and mid infrared range performed at the ANKA-IR beamline. We intend to define the hydrocarbon fluid inclusion content i.e. the semiquantitative oil composition, the solid minerals associated as a mechanically entrapped minerals and/or as a daughter minerals (carbonate, sulfates, quartz) and alphaltenes.

References

GUILHAUMOU, N., DUMAS, P., CARR, G. L. & WILLIAMS, G. P. (1998): Synchrotron Infrared Microspectrometry applied to petrography in the micron scale range: Fluid chemical analysis and mapping. Applied Spectroscopy, **52**, 8, 176-184.