THE INFRARED MICRO-SPECTROSCOPY FACILITY AT THE SYNCHROTRON ANKA: MINERALOGICAL APPLICATIONS

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ANKA is a new synchrotron at the Forschungszentrum Karlsruhe. It has been in user operation since March 2003 and it is running routinely at 2.5 GeV beam energy and 200 mA current.
At the infrared (IR) beamline, we have been developing mineralogical applications based on Fourier transform IR micro-spectroscopy. Our aim is to address the need for more sophisticated investigations by using the advantages of the synchrotron radiation compared to laboratory sources such as higher flux in the far IR and higher spatial resolution because of the higher brilliance in the complete IR spectral range. 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 is equipped with an infrared microscope (Bruker IRscopeII) covering the far-, mid- and near-IR ranges. Set-ups for studies at low/high temperatures as well as at high pressure are under construction.
Our research directions include the study of new and not fully understood mineral crystal structures, transitions from semi-amorphous to crystalline state, mechanisms of incorporation of toxic ions into crystal structures, etc.
In many mineralogical applications there is a need for spatially resolved studies at the microscale. IR and Raman microscopy combines the rich crystallochemical specificity for samples even in amorphous state associated with vibrational spectroscopy. Compared to the spatial resolution achieved by Raman micro-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 μm. High brilliance is desirable for any measurement with a limited "throughput" By using synchrotron-based IR micro-spectroscopy we can investigate samples down to the diffraction limit.
In this presentation two different examples of synchrotron based infrared studies combined with Raman spectroscopy with application to cement mineralogy, e.g. mechanisms of incorporation of Zn and the reaction of the crystal structure of synthetic Ca-gyrolite upon heating, and characterization of hydrocarbon bearing small sized fluid inclusions in minerals, that demonstrate the power of this technique will be given.