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Invited talk: Multimode InfraRed Imaging and Microspectroscopy at Diamond: research perspectives in Soft Condensed Matter

Wednesday, 17 June 2015 14:30 (50 minutes)

Infrared (IR) MicroSpectroscopy is a quantitative analytical probe extensively applied to soft condensed matter because of its high molecular sensitivity and specificity.

Fourier Transform IR (FTIR) technique is extremely effective in revealing optically-active vibrational modes of molecules, or *IR fingerprinting* molecular groups, at the microscopic scale. The combination of microFTIR with Synchrotron Radiation (SR) broadband and brightness provides an unique diffraction limited IR microprobe. In fact, SRIR photon flux density is up to 10^3 times higher than conventional sources extending simultaneously from the near-IR (\lambda> 1 mm) up to the far-IR (\lambda < 2 mm). At MIRIAM beamline of Diamond such advantages are fully exploited to allow both the highest spatial resolution optically attainable in IR microscopy (practically \deltax ~ \alpha fwhm), and an excellent spectral quality (figure of merit signal/noise>3000 rms on 5x5 mm^2 spot in 30 sec) for vibrational spectroscopy across the whole IR range.

The initial Life Science driver for MIRIAM of biochemical analysis of fixed cell cultures and tissue sections relevant to e.g. cancer, stem cell research and pathology, is now routine in confocal IR microscopy [1]. The new research frontier for biomedicine is *ex vivo* and real time IR microanalysis of living single cell, i.e. the study of subcellular metabolism as well as extracellular interactions via full field IR imaging e.g. imaging isotopic gradient around/inside living fibroblasts [2].

A new class of experiments have been pioneered at MIRIAM in the last couple of years, namely the micro-analysis of gas-solid interaction controlled by temperature which are especially important for the chemistry of catalysis at single crystal level, or the dynamic of functionalized Metal-Organic-Frames [3].

Recently, SR IR for microchemical analysis on painting fragments has become a reliable technique and the research in Cultural Heritage at MIRIAM is quite successful, too [4].

Finally, the optimization of Diamond Coherent Synchrotron Radiation emission has expanded MIRIAM experimental capability for absorption spectroscopy in the "THz gap"domain. This is particular relevant in the study of large molecule collective modes e.g. the physics of MOFs [5], as well as the study of the water interaction with protein in solution [6].

References

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4 V. Beltran et al. Microchemical Journal 118 (2015) 115, Micro infrared spectroscopy discrimination capability of compounds in complex matrices of thin layers in real sample coatings from artworks

5 M. R. Ryder et al. Physical Review Letter 113 (2014) 215502, Identifying the Role of Terahertz Vibrations in Metal-Organic Frameworks: From Gate-Opening Phenomenon to Shear-Driven Structural Destabilization.

6 J.W. Bye et al. J. Physical Chemistry A 118 (2014) 83, Analysis of the Hydration Water around Bovine Serum Albumin Using Terahertz Coherent Synchrotron Radiation.

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