

Identification of Pathological Conditions Using Synchrotron Radiation

Luca Quaroni, Canadian Light Source

Traditionally pathological conditions have been diagnosed and studied by a combination of morphological inspection and physical and chemical analysis, with effective diagnosis requiring the joint application of multiple techniques.

Continuous developments constantly improve existing technology and introduce new imaging and analytical techniques. Several recent advances have involved applications of synchrotron radiation. Advantages provided by synchrotron light vary with the technique and range from enhanced imaging contrast, to improved spatial resolution, higher sensitivity, higher penetration depth in samples, and faster measurement rates.

Among the various techniques, IR spectromicroscopy is characterized by being capable of providing both imaging capabilities and compositional analysis. The spectroscopic properties of tissue samples in the infrared region are dominated by chemical composition and molecular structure. Pathological conditions can therefore be detected indirectly via the compositional changes resulting from associated alterations of metabolism.

Diagnosis of a pathological condition from the spectral analysis of infrared maps can be extremely fast in cases where the specific molecular changes induced by the condition are known, but painstakingly slow when this is not the case. In such situations, protocols for automated image analysis and pattern identification are coupled to spectroscopic analysis to permit high-throughput screening of the spectral properties of large images.

Developments in the use of synchrotron radiation are currently pushing the frontier of the technique in two directions. In one direction, the gain in spatial resolution is used to allow the study and identification of pathological conditions from single cell analysis. In the other direction, integration with other synchrotron techniques available on-site is being used both to complement the diagnostic capabilities of IR spectromicroscopy and to increase the understanding of the molecular processes underlying specific pathologies.