A New Infrared Microspectroscopy Facility at the Daresbury SRS – Current Performance, Latest Results and Future Developments.

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A new beamline, dedicated to infrared microspectroscopy, has been commissioned at the Daresbury Laboratory Synchrotron Radiation Source (SRS) in the UK. This facility has been optimised for operation in the mid infrared region of the spectrum, and became a user facility in late 2003. The beamline supersede the microscopy endstation previously operating on the far infrared surface science beamline, and which had operated successfully for several years. Improvements incorporated in the new facility include a more stable mounting platform for the microscope and its optics, a higher throughput of mid infrared radiation, and a more spacious user accommodation at the beamline.

The optical components of the new beamline can be considered in two sections: the primary extraction optics installed in the synchrotron ring tunnel, and the secondary collimating optics on the synchrotron roof. A high aperture dipole vessel allows extraction of 30 x 30 mrads of synchrotron light which is collected by a spherical mirror M_1 situated 5 m from the source. This mirror reflects and focuses the beam back towards the source, deflecting the beam downward by 2.7˚. The beam is then collected by a plane mirror M_2 and reflected upward toward the synchrotron vacuum exit window which is made of KRS5 (thallium bromoiodide) and located above the synchrotron shield roof. This produces a 1:1 image of the source approximately 50 mm above the synchrotron exit window. The secondary optics are situated above the synchrotron exit window and comprise a plane mirror M_3 reflecting the beam onto a spherical mirror M_4 located so as to produce a horizontal collimated beam. This beam is transported to the endstation by two adjustable plane mirrors. The secondary optics are maintained under vacuum at about 5 x 10^{-3} Torr, with the beam exiting through a caesium iodide window into the final beamline section, which is purged with dry air. Three alternative focal length M_4 mirrors are available at different distances from the beam focus, allowing the resulting collimated beam to be tailored more closely to the experimental equipment in use.
As expected, the performance of this facility is significantly better than the original microscopy endstation, with high signal-to-noise, and an unapertured beam footprint at the sample of 8x8 microns.
Future developments include the installation of a Perkin Elmer Spotlight imaging system, and the upgrade of the Thermo Nicolet Continuum microscope to operate with a high speed 8x8 element detector. Near field developments based on the photothermal IR technique are also continuing at the SRS.

The new beamline is currently fully subscribed until March 2005, and is being used by a significant number of biomedical researchers. Applications for the study of breast cancer, cervical cancer, bone degeneration, prostate cancer and lung cancer have been received. The research group at Daresbury has been continuing to explore the possible application of infrared spectroscopy in the screening for cancer. Infrared transmission spectra were collected from individual cells within normal and cancerous tissues, at a spatial resolution of 10 microns. The spectra were then analysed using the chemometrics package Pirouette® (Infometrix Inc., USA) by both hierarchical cluster (HC) analysis and principal component (PC) analysis. HC analysis was able to discriminate between malignant cell and stroma within tumour sections, as well as keratinised tumour cells. By applying Nearest Neighbour classification following PC analysis, the data set built up was found to be suitable for the correct classification of cells within similar tissue regions, including those from other patients.