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Infrared Environmental Imaging

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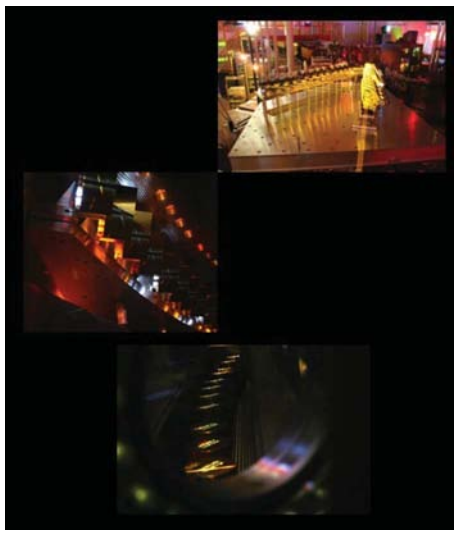
IRENI: Infrared Environmental Imaging at the Synchrotron Radiation Center

The Synchrotron Radiation Center (SRC) and Carol Hirschmugl (UW-Milwaukee) have designed, constructed, and are presently commissioning a new, mid-infrared beamline (IRENI) extracting 320 hor.$\times$25 vert. mrads^2 to homogeneously illuminate a commercial IR microscope equipped with an infrared Focal Plane Array detector. The swath of radiation from the SRC is extracted as 12 beams and recombined into a 3$\times$4 bundle of beams that is refocused onto a sample plane of an infrared microscope illuminating 40$\times$60 micron^2 sample area. This new facility will provide the opportunity to obtain chemical images with diffraction-limited (or better) resolution in minutes.

From the earliest experiments with optical microscopes, researchers have examined the appearance of microbes and other microscopic plants and animals; they have strived to identify the various organelles and sub-cellular structures evident, helping them to infer their biological function. Beyond the visual appearance of these structures, knowledge of their chemical makeup would provide great insight into how these sub-cellular structures function in a living cell. Moreover, tracking the changes in their chemical makeup would allow scientists to understand the organism's response to changing environmental conditions. The development of a chemically sensitive infrared microscope with multiple, parallel detection channels will greatly expand the ability to examine such biological structures, and to track their changes over minutes.

In the case of Hirschmugl's work, initial research projects will include examining kinetics of living cells (phytoplankton), fungi and bacteria-mineral interactions. This microscope will also be available for the user community across a wide array of disciplines (e.g. soft matter condensed physics, nanoscience, biology, chemistry, veterinary science, engineering, environmental science and geology), providing a new interdisciplinary tool to the broader scientific community and a teaching tool for the many pre-collegiate, undergraduate, and graduate students that come to SRC each year as part of several science education programs and in collaborations with faculty mentors.

This work has been done with support from an NSF Major Research Instrumentation grant (DMR-0619759) and the Synchrotron Radiation Center, which is also supported by NSF (DMR-0537588).



A series of pictures showing illuminated mirrors in the beam path for IRENI. In the right photo, the array of illuminated toroids (nine of twelve are shown), the first array of mirrors in the beamline, refocus the synchrotron beam as it exits the synchrotron. Notice two bright rectangles of light just above and below the center. In addition, there is a large shadow across the center of each mirror, which is due to a water-cooled tube to absorb the higher energy soft X-rays and UV radiation. The bottom, central picture shows the array of plane mirrors (eleven of twelve are shown), which redirects the beams through exit windows of the UHV system housing the two first arrays of mirrors. The upper-left picture shows the final 24 illuminated mirrors that collect the swath of radiation from the synchrotron and recombine it into a collimated bundle of 12 beams.

CAROL HIRSCHMUGL
UW-Milwaukee

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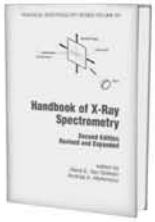

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