to obtain the x-ray dose distribution on photoresist and thereby distribution of optical density of the sample in x-ray spectral region. Work on extending this technique to stereoscopic imaging using two x-ray sources in different spectral regions is in progress.

Measurement of absorption coefficient of CO_2 laser windows

Single-mode line-tunable CO_2 lasers are used extensively for pumping molecular gas lasers and for spectroscopic applications. The operational characteristics of these lasers are significantly influenced by the undesirable absorption in intracavity components, such as the windows on a gas discharge section. Knowledge of loss introduced by the intracavity windows at wavelength of laser operation is therefore often essential. Although a number of methods are available for this purpose, each has its limitations. For example, measurement of the typically low absorption coefficient ($\sim10^{-3}$ cm^{-1}) of laser-grade window material with a dual-beam infrared spectrophotometer requires a sample thickness of the order of a few centimeters to ensure a measurable transmission change of ~1%, whereas the window thickness typically used in continuous-wave CO_2 lasers is a few millimeters. A new technique recently demonstrated at CAT allows measurement of absorption co-efficients of the order of $\sim10^{-3}$ cm^{-1} in windows a few millimeter thick.

This technique involves measurement of the output power of a single mode CW CO_2 laser as a function of its cavity length. This is conveniently achieved by a change in the applied voltage to a piezoelectronic transducer (PZT) on which one of the cavity mirrors is mounted. The curve of the output power versus cavity length shows hysteresis. This has earlier been shown to arise due to heating of the intracavity optical components in the presence of the laser beam and the consequent changes in the resonator path length. Since the laser heating induced change in path length (ΔL) depends on the absorption co-efficient of the window, knowing ΔL, absorption co-efficient can be determined. The change in the resonator path length arising due to laser induced heating of a given component and hence its absorption coefficient can be determined by measuring the hysteresis in the power-tuning curve both without and with the insertion of this component in the cavity and by ensuring that the laser operates at the same power level in both cases. The latter can be conveniently achieved by a small adjustment of discharge current. The technique has been used to measure absorption co-efficient of 3mm thick ZnSe and KCl windows. The measured values were found to be in reasonable aggrement with the values obtained by other methods.

Cover photograph *shows An industrial model of high power transverse flow CW CO_2 laser, developed and built at CAT. It gives 3.5 kW laser power and is coupled with a CNC work - table (3m x 1m span).*

Susceptibility Bridge

AC-susceptometers are widely used to study the magnetic response of magnetic materials and superconductors. This apparatus is particularly popular because starting from relatively fast non-destructive testing of new materials to elaborate study of magnetic properties as a function of temperature, frequency and applied field (both driving ac-field and dc-bias field) can be performed with a single apparatus. Such a facility with variable temperature ($80K<T<300K$), variable frequency ($1Hz < f < 10KHz$), sample environment and also with the capability of higher harmonic susceptibility measurement has been built at CAT.

Operation of an ac-susceptometer is based on detection of emf induced by an alternating field in a pick-up coil that contains the magnetic or superconducting sample. Pick-up coil system used in ac-susceptometer at CAT is formed by two axially symmetric oppositely wound coils mounted in series. A primary coil concentric with two secondaries carries a current that generates alternating field. Ideally in absence of a sample, the induced emf is zero. When a sample is introduced in one of the secondaries, an imbalance in the induced emf is created, which is proportional to susceptibility of the sample. This imbalance is measured directly by synchronous detection using a lock-in amplifier. In addition, the lock-in detection, is particularly useful while working in a noisy (electro-magnetic) environment.

To increase sensitivity of the apparatus further, a home made mutual inductance bridge, which can compensate imbalance in induced-emf, is incorporated. In this configuration, lock-in amplifier is used as a null detector.

The mutual inductance bridge can balance resistive and inductive part of the signal separately using a variable resistor and a variable mutual inductor. Instead of using a commercial variable mutual inductance (which is a costly item), in present bridge variable mutual inductance is simulated using an electronic circuit comprising a standard fixed inductance and operational amplifiers. Sensitivity of the order of 5×10^{-6} emu has been achieved in low frequency range and with some care it should not be difficult to extend it to 10^{-7} emu range. At present the apparatus is working regularly in the temperature range $80K<T<300K$ and frequency range $1Hz<f<1KHz$. Work is in progress to extend the temperature range down to 4.2 K and frequency range to 100 KHz.

With help of a sophisticated lock-in amplifier (SR830) this apparatus is also used to measure non-linear magnetic response of various materials in the form of higher harmonic susceptibility.

This apparatus has been developed in steps. Since early 1997 it has been automated (using a PC) for synchronous signal detection using a lock-in amplifier. A user-friendly software is developed in 'C' language for this purpose. The effort is now focused in building an intelligent mutual inductance bridge which can be controlled by a computer, so that the apparatus can be completely automated even in its highest sensitivity range.

The apparatus has been used during recent past in non-destructive testing of new giant magneto-resistance materials