Cell using avalanche transistor stacks, provides a laser pulse of 7 ns (FWHM) duration. The operation choice between 28 nsec and 7 nsec pulse durations can be accomplished using a selector switch, without changing the beam path and the alignment.

The output beam from the pulse slicer is magnified using suitable telescopic lens combinations and fed to the amplifiers. Whereas the oscillator uses a double elliptical pump cavity, the first three amplifiers have clover-leaf reflectors and the fourth amplifier has a cylindrical reflector cavity. The cavities are designed so as to provide an optimum combination of high coupling efficiency with uniform pumping in the radial direction. The clover-leaf reflector geometry in the first three amplifiers provides 60% higher efficiency than a cylindrical reflector would. The electropolished aluminum reflectors provide an enhanced effective coupling of the pump radiation to the laser rod about 15% and 25% over those for mechanically polished aluminum reflectors and the gold electroplated cavity respectively.

As the laser beam propagates through the various amplifier stages, its spatial profile develops diffraction rings due to beam aperturing and some inhomogenities present in the medium. Two vacuum spatial filters cum image relay systems are used to remove high frequency spatial noise from the laser beam profile to avoid any possible damage due to self-focussing. These are placed between the 2nd and the 3rd amplifiers, and the 3rd and the 4th amplifiers respectively, and have a cutoff spatial frequency of 5 cm^{-1} with a laser energy transmission of about 75% and about 80% respectively.

A Faraday optical isolator is installed at the end of the laser chain to prevent any laser light, backreflected from the plasma, from propagating backwards through the amplifier chain which could cause extensive damage to the various optical components. This isolator uses an FR-5 glass placed in a solenoid coil producing a pulsed magnetic field of about 15 kG. Its isolation factor has been measured by a probe laser beam to be about 6500 for the back-reflected beam, whereas the transmission of the forward direction laser beam is about 92%.

Studies on laser tissue interaction

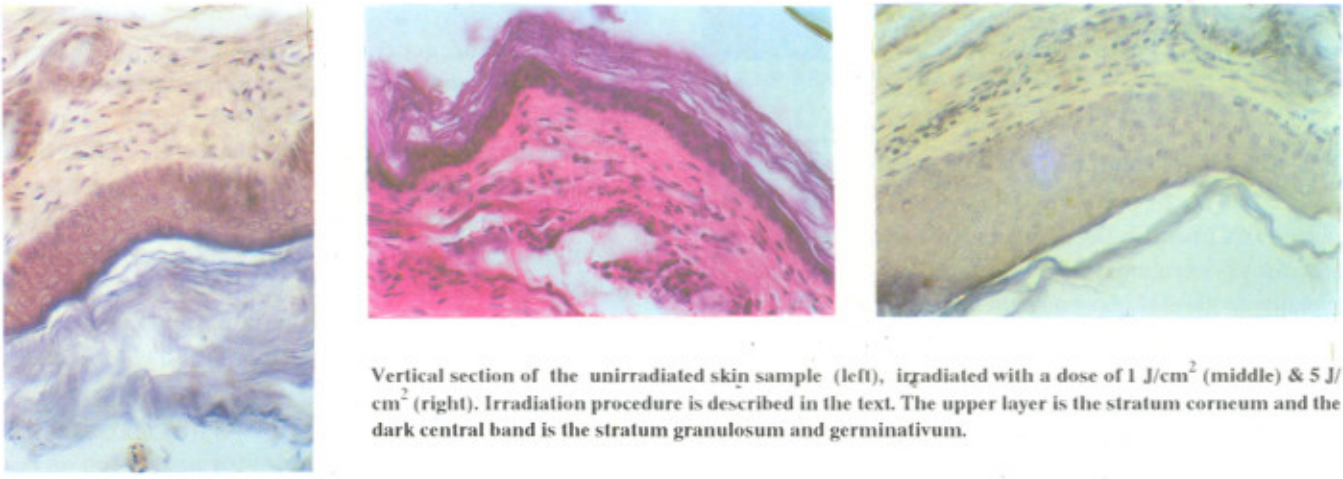
Studies are being carried out to investigate the effect of laser irradiation on animal models/ bacterial systems and on the use of laser induced fluorescence from tissues for discrimination of neo-plastic tissue from normal.

Autofluorescence spectra of malignant and adjoining normal human tissues have been recorded both from intact tissues and from tissue extracts at various excitation wavelengths. The spectra showed significant differences between malignant and normal tissue with respect to the fluorescence yield, bandwidth and spectral intensity distribution. These may be exploited for discrimination of a neo-plastic tissue from a normal one.

Histological studies on the scrotal skin of Indian albino rabbits irradiated with N_2 laser to a dose of 1 J/cm^2 to 5 J/cm^2 for 10 days at 24 hr regular interval showed marked differences in the epidermal area compared to the unirradiated sham. At the lower dose (1 J/cm^2) the stratum corneum was observed to be considerably thinner in the irradiated skin compared to the unirradiated. Further, the total height of the stratum granulosum and stratum germinativum in the irradiated skin was considerably increased and the cells of the stratum germinativum were more active compared to the unirradiated skin. In contrast, at the higher dose (5 J/cm^2), the thickness of active epidermal layers was significantly smaller than both the sham and the 1 J/cm^2 samples, while that of the stratum corneum was intermediate between the two. These observations suggest that the lower dose leads to a proliferation of cells in the stratum germinativum and inhibition occurs at the higher dose used.

Optical limiting in C_{60}

Nonlinear optical response of fullerenes, the recently discovered new form of carbon, is currently being inves-

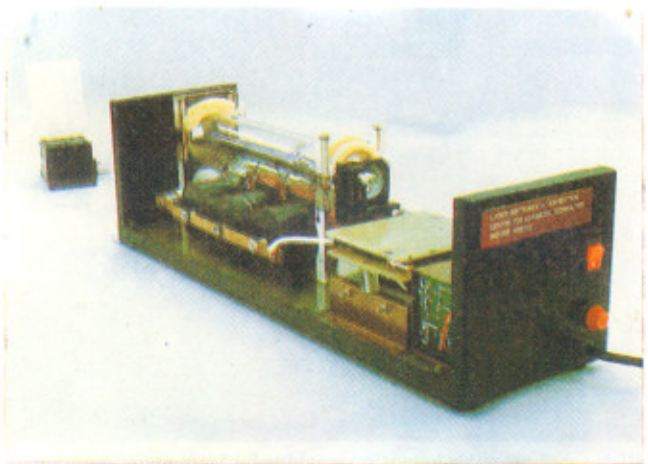


Vertical section of the unirradiated skin sample (left), irradiated with a dose of 1 J/cm^2 (middle) & 5 J/cm^2 (right). Irradiation procedure is described in the text. The upper layer is the stratum corneum and the dark central band is the stratum granulosum and germinativum.

tigated in several laboratories worldwide. One nonlinear optical effect which appears promising for device application is optical limiting of nanosecond duration visible laser pulses in C_{60} solutions. Experimental and theoretical study of this phenomenon at CAT has led to a better understanding of the underlying physical mechanism. In C_{60}, absorption in the visible region results in excitation of the molecules to the long-lived triplet state. The absorption from this level is much stronger than that from the ground state and earlier it was believed that this 'reverse saturable absorption' is responsible for the observed limiting. The work at CAT has shown that this mechanism cannot fully account for the experimental observations and, in fact, a stronger role in the limiting action is played by induced scattering in C_{60} solutions. The scattering has been found to be laser fluence dependent and appears to be of thermal origin. Furthermore, nonlinear refraction in C_{60} solution, resulting from refractive index changes which can be due to heating and population transfer to the triplet state, has been shown to be important.

High resolution FIR and IR spectroscopy

A torsion-rotation-distorsion interaction Hamiltonian has been developed for symmetric and slightly asymmetric molecules capable of hindered internal rotation in a three fold potential barrier. The model has been successfully applied to the case of methyl alcohol, which is a slightly asymmetric molecule and is the best source of optically pumped FIR laser lines. The analysis has resulted in the interpretation of torsion-rotation and vibration-torsion-rotation high resolution Fourier transform spectra of methanol and some of its isotopic derivatives, e.g., $^{13}CH_3OH$, CD_3OH, $^{13}CD_3OH$, and CH_3OD. For the parent species the IR analysis resulted in the assignments and predictions of many optically pumped FIR laser lines. Of particular importance is the identification and prediction of FIR laser lines from the highly excited torsional states in the C-O stretch state. Using accurate combination loops the frequencies of the emission lines obtained to at least an order of magnitude better accuracy than can be obtained from direct wavelength measurements. This study of the FIR absorption spectrum (20 - 350 cm^{-1}) has resulted in an atlas of about 20,000 precise line positions with an accuracy of about 5 MHz. This atlas has been identified by the Journal of Molecular Spectroscopy as a secondary wavenumber standard in the FIR region.



Sealed-off nitrogen laser developed at CAT.

The study on the other isotopes of methanol has made it possible to interpret their laser Stark spectra and double resonance spectra. A Coriolis interaction model has also been developed for the perturbation observed in the excited vibrational state and to identify and predict many optically pumped FIR laser lines. The laser Stark study has provided accurate dipole moments and zero field transition frequencies in the ground state. Accurate molecular parameters are obtained for these isotopes. The interaction model was also applied in the case of a molecule with symmetric framework (ethane-D_3) to interpret the weak and complicated spectra in the three lowest torsional states and the molecular parameters were determined. These results will be useful for finding new emission lines with the optically pumped FIR laser being developed at CAT.

ACCELERATOR PROGRAMME

RF ion source

A radio frequency (RF) ion source has been developed for a 150 keV ion implantor. This ion source is capable of providing any gaseous ion. An indigeneously developed RF power source that operates at a frequency of 189.7 MHz has been used for this purpose.

The RF source consists of a quartz tube (44 mm diameter, 200 mm length) with a tungsten electrode fused at one end. The extraction potential is applied to this electrode. To prevent damage to this electrode from the electrons, a perforated quartz shield is provided. On the other end of the quartz tube an extraction port, having a highly polished aluminum canal with an aluminum collimator, is fixed. This assembly is housed in a stainless steel jacket which is insulated from it by a ceramic ring. The gas is fed into the source using a fine control needle valve. The RF power is transferred to the quartz tube by a capacitive coupling via an RF-matching network. The capacitance can be varied from 0 to 8 pF. Focusing of the ions at the extraction port is achieved by a solenoidal field.

Helium and argon ions have been extracted using this source in the pressure range 10^{-2} to 10^{-5} mbar. The RF

Cover: *Scanning electron micrograph showing surface topography of porous silicon.*