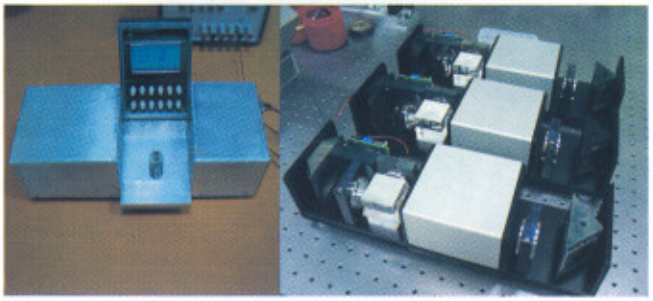

Fig. L.10.1 The new version of the density measurement station

The optical scanning is achieved using a polygon mounted on a brush less dc motor, which scans the laser beam, and a collimating lens generates the line scan. The duration for which the pellet obstructs the laser gives a measure of its size. The diameter and length of the pellet placed in the collimated scan region are simultaneously measured and are used to calculate the geometric volume of the fuel pellet. The weight of the pellet is acquired from a weighing machine interfaced to the system. The sintered density of fuel pellets is needed before they are taken up for assembly into fuel bundles. Three such systems have been developed for NFC, Hyderabad.

(Contributed by: A.G. Bhujle; bhujle@cat.ernet.in, S. Raja, K. Aneesh)

L.11 Digital speckle metrology

When a coherent wave is reflected from or transmitted through an optically rough surface it forms what is called a speckle pattern. It arises from the self-interference of waves generated by diffuse objects. The speckle patterns are recorded using high-resolution CCD cameras, are electronically stored and correlated numerically. Shearing Speckle Interferometry is a laser based, optical, non-contact and non-destructive method widely used for the stress and strain analysis of loaded structures and for non-destructive testing. It is an optical method based on the principle of speckle correlation where interferometer is used in shearing mode.

A system based on shearing speckle interferometry has been set up to carry out analysis, and display the resulting displacement field and the interferogram in real time. The object under inspection is illuminated with an expanded laser beam. A speckle pattern of the unstressed object is initially captured and stored in a computer as a reference image. The object is then stressed artificially by either mechanical, pressure or thermal methods, which in turn causes the object to deform. The image of the deformed object is acquired and stored as deformed image (fig.L.11.1).

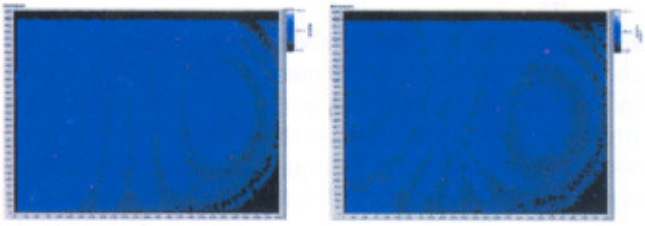

Fig. L.11.1 The specklegram of a normal and a stressed plate

Recording these subsequent speckle patterns, and subtracting them produce an image, which consists of alternating black and white fringes. The fringes correspond to the gradient of the deformation and can be used to calculate the out of plane deformation of the object. This system is being developed at CAT as a prototype for NDT feasibility studies.

(Contributed by: S. Raja, A.G. Bhujle; bhujle@cat.ernet.in)

L.12 pH dependent binding of Chlorin-p6 with lipid membranes: A fluorescence spectroscopic study

Studies are being carried out to evaluate the use of Chlorin-p6 (Cp6), a Chlorophyll derivative as a potential drug for photodynamic therapy. Our earlier studies showed that due to the presence of a number of carboxylic groups the hydrophobicity of Cp6 and hence its aggregation depends strongly on pH [*Dutta et. al. Photochem. Photobiol 75 (2002) 488*]. Since binding of Cp6 to lipid membranes and thus its cellular uptake is expected to depend on its hydrophobicity, we investigated the pH dependence of the binding of Cp6, with a lipid membrane (phosphatidyl choline liposomes).

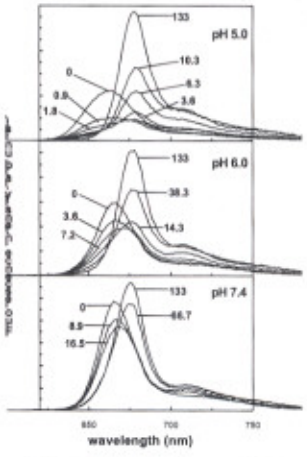

***Fig. L.12.1a** Evolution of the fluorescence of Cp6 with increasing amount of liposome. The increasing numbers indicate increasing amount of liposomes in phosphate buffer.*

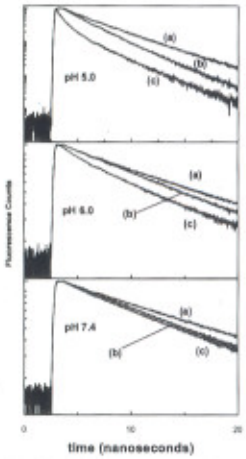

***Fig. L.12.1b** Fluorescence decays of Cp6 in (a) Maximum liposome; (b) No liposome and (c) with liposome concentrations corresponding to numbers 3.6, 14.3 and 16.5 in fig. 1a, for pH 5.0, 6.0 and 7.4 respectively.*

The changes observed in the absorption and emission spectra of the drug on addition of liposomes were considerably larger at pH 5.0 than at higher pH investigated (6.0 and 7.4). At pH 5.0, with increasing lipid concentration, first a decrease was observed in the emission intensity of the 660 nm band dominant in the drug emission in neat buffer. At higher lipid concentration, fluorescence intensity increased with the dominant band shifting to ~ 680 nm (fig. L.12.1a). These observations are consistent with the fact that the neutral species of the drug abundant at low pH will bend strongly enough even at low lipid concentration, and suggest that, as a consequence, the amount of drug per liposome increases up to such an extent that self quenching of fluorescence occurs. This effect gets reduced as the pH of the medium is increased, as increased pH produces more anionic species, and since they are less hydrophobic than the neutral ones, the binding with the liposomes becomes less favorable and consequently the self-quenching of fluorescence in the lipid bilayer decreases.

To further confirm these aspects we measured the pH dependence of the fluorescence decay time of the drug for varying lipid concentration. The results in fig. L.12. 1b show that for a given concentration of the drug, at pH 5.0 the fluorescence decay was faster for liposome concentrations where the fluorescence quenching was observed to be significant and was slower at larger liposome concentrations. For higher pH the dependence of the decay times on concentration of liposomes was much smaller. Similarly fluorescence quenching experiments with iodide ions confirmed that while at pH 5.0 the drug bound to liposome is inaccessible to the quencher and hence located deep inside the lipid bilayer, for pH 6.0 and higher where the anionic species are a majority, the drug binds closer to the liposome interface. [For details see: *K. Das, B. Jain, A. Dube and P.K. Gupta, Chemical Physics Letters, Vol. 401, page 185-188, (2005)*].

(Contributed by : P. K. Gupta; pkgupta@cat.ernet.in)

L.13 Laser welding of automobile transmission gear assemblies

Laser welding of automobile transmission gear assemblies has been established. In the first phase of the study, a few gear assembly blanks were laser welded using the indigenously developed high power continuous wave CO_2 laser, and mechanical and metallurgical characterizations were carried out. Good quality weld, up to 4 mm depth, with narrow heat affected zone was produced at 2.5-3 kW laser power and 1mm/min weld speed. Argon gas was used as a shielding gas during laser welding. Mechanical strength of the weld joint confirmed the specifications.

Fig. L.13.1 *Laser welded gear assemblies*

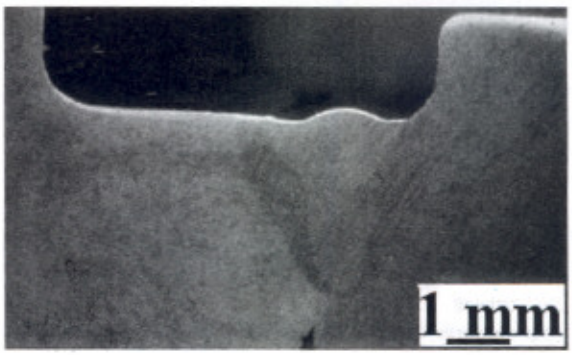

Fig. L.13.2 *Macroscopic view of Laser weldment cross-section*

In the second phase, about 230 numbers of different kinds of automobile transmission gear assemblies were laser welded for functional testing. Fig. L.13.1 presents photographs of laser welded gear assemblies, while fig. L.13.2 show a macroscopic view of the cross-section and close up of one of the laser weldments respectively.

(Contributed by: Harish Kumar; harishk@cat.ernet.in and A.K. Nath)

L.14 Improved mechanical properties of Inconel-625 components by laser rapid manufacturing

Laser rapid manufacturing (LRM) is an upcoming rapid manufacturing technology, being developed at the various laboratories around the world. It is similar to laser cladding at process level with different end applications. In general, laser cladding technique is used to deposit material on the substrate, either to improve the surface properties or to refurbish the worn out parts, while LRM is capable of near net shaping the components by layer-by-layer deposition of the material directly from CAD model.