L.3 Enhanced zone plate coded microscopy of large size objects

Zone plate coded imaging (ZPCI) is an important technique for imaging any short wavelength incoherent radiation, which is difficult to focus using conventional reflective and refractive optics. While ZPCI enjoys large radiation collection efficiency, size of the source to be microscopically imaged is limited to the diameter of the first zone of the zone plate used for encoding. This limit on the field of view comes from interference of out-of-focus multi diffraction orders with the focused order during reconstruction of the object as illustrated in the fig.L.3.1. An enhanced digital decoding technique has been devised for digital reconstruction of the object. It increases the field of view by a factor of three without affecting the resolution and signal to noise ratio.

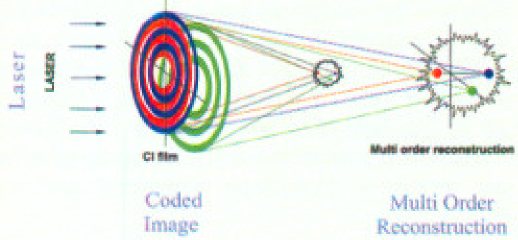

Fig. L.3.1 Multi order reconstruction of the object from a coded-image.

The technique is based on the fact that spatial frequency in a given order at a particular point in the coded image is proportional to the radial distance of this point from the centre, and it increases in proportion to the order number of diffraction. This implies that there exists progressively increasing higher cut-off limits of spatial frequency spectrum of different diffraction orders with increasing order-number. Further, for a known highest spatial frequency of the object, the information for higher orders will be contained in a disc of smaller radius in the coded image and vice versa. Therefore, the noise contribution from lower orders to a given higher order can be reduced by spatially limiting the coded image during digital reconstruction. Similarly, noise from higher orders to a lower order image can be decreased by selective propagation of the spatial frequency components after applying a low pass filter. This suppresses the inter-order noise leading to a larger field of view of the object. A computer program has been developed for digital reconstruction of the object from the coded image. Because of enhancement in the field of view this scheme can be useful for x-ray imaging of laser produced plasmas and even for imaging particle-emissions like neutrons from inertial confinement fusion.

(Contributed by: A.S. Joshi; asjoshi@cat.ernet.in)

L.4 Fabrication of nano structured velvet targets for sub-picosecond lasers

Nano structured velvet targets consist of a surface of end-standing 10-200nm diameter metallic fibers, in a structure resembling velvet fabric. Such metallic velvets are found to produce bright x-ray pulses of a few pico-second with high x-ray energy conversion. These velvet targets are electrochemically fabricated on aluminum substrates by a four-stage process, consisting of electropolishing, anodic oxidation, pore widening and electro deposition.

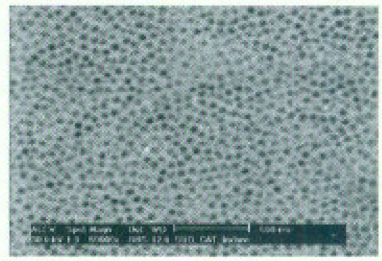

Fig.L.4.1 SEM image of Electropolished Al foil

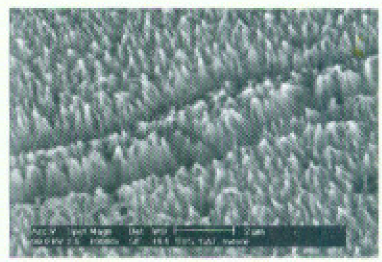

Fig.L.4.2 SEM image if anodised Al foil

Aluminum samples were first electropolished in a solution of ethanol and perchloric acid at 8°C for forming ordered hexagonal patterns (fig.L.4.1). After electropolishing they were anodized at 24°C in oxalic acid electrolyte with lead counter electrode (fig. L.4.2). The temperatures for both these processes were maintained using a constant temperature bath. The pores formed during anodization were widened in phosphoric acid at 37°C for 30 minutes. Nickel was electrodeposited inside the widened pores in a sulphate electrolyte using alternating current at 60°C for 10 minutes.

(Contributed by: P.Ramsankar; prs@cat.ernet.in)

L.5 Photodynamic inactivation of antibiotic resistant bacteria -*Pseudomonas aeruginosa*

Photodynamic therapy (PDT) is a promising approach for management of antibiotic resistant bacteria. It involves destruction of target cells by reactive oxygen species generated by photoexcitation of a photosensitiser bound to the bacteria. Whereas the use of exogenous photosensitiser has proved very effective for inactivation of Gram-positive bacteria, it has not been that effective for Gram-negative bacteria. This is due to presence of highly organized outer membrane in Gram-negative bacteria, which hinders the uptake of photosensitizer. Another approach for photodynamic inactivation of bacteria is to make use of endogenously produced porphyrins, which can also serve as efficient photosensitizers. Enhancement of endogenous synthesis of porphyrins can be achieved by addition of δ-aminolaevulinic acid (ALA), a precursor for haem synthesis. For Gram-negative bacteria use of ALA has the additional advantage that in contrast to exogenously administered porphyrins, which are less permeable, ALA can penetrate Gram-negative bacteria through hydrophilic pores present in the membrane. However, previous attempt to use ALA induced porphyrins for photodynamic inactivation of *Pseudomonas. aeruginosa* (a Gram-negative bacteria often a cause of infections in hospitalized patients) did not give satisfactory results due to insufficient formation of photodynamically active protoporphyrins. Therefore, the use of glutathione (GSH), to increase the biosynthesis of porphyrins in bacteria was investigated

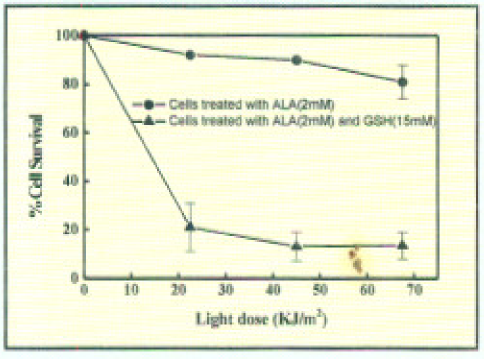

Fig.L.5.1 Survival of cells treated with ALA and irradiated with light at 405nm with and without GSH.

Large decrease in cell survival was observed in cells treated with GSH as compared to cells without GSH. Cell death was 85% as compared 10% observed without GSH for the same light dose (22.5kJ/m^2) (fig.L.5.1). Experiments revealed that the enhanced inactivation in presence of GSH is not only due to the expected enhancement in the synthesis of porphyrins but presence of GSH also reduces the photoirradiation induced conversion of photodynamically more active protoporphyrins to less active coproporphyrins. These findings may be useful for treatment of antibiotic resistant strain of *Pseudomonas aeruginosa*, which often cause infection of burn injuries and surgical wounds in hospitalized patients.

(Contributed by: Dr. PK Gupta; pkgupta@cat.ernet.in)

L.6 Depolarization of light in tissue phantoms – effect of a distribution in the size of scatterers

The studies show that the depolarization behavior of light on propagation through a sample having a mixture of suspension of monodisperse polystyrene microspheres of two different sizes is dominated by the smaller of the two scatterers. In contrast, the estimates for the anisotropy parameter (g) for this sample, obtained from a measurement of the angular distribution of the scattered light, are observed to be closer to the value corresponding to the larger of the two scatterers. These results imply that the depolarization behavior of biological tissue having scatterers ranging in size from 0.1μm (mitochondria, lisosomes, perixosomes and other sub-cellular structures) to ~10 -20μm (cell as a whole) will be similar to that of a monodisperse medium having scatterers of the lower size band. However the anisotropy parameter for the biological tissue will correspond to that of a monodisperse medium having scatterers of the larger size band. These results are able to explain the apparent discrepancy reported in literature in the depolarization behavior of a biological tissue and matched monodisperse scattering samples having the same value of anisotropy parameter and optical thickness.

(Contributed by: Dr. PK Gupta; pkgupta@cat.ernet.in)

L.7 Growth of large size KDP crystals and device fabrication

Potassium dihydrogen phosphate (KDP) crystals are important for laser fusion activity due to their ability to generate second and third harmonics of high power Nd: YAG and Nd: Glass lasers. To face high-energy lasers, high quality KDP crystals are required in large size. We have succeeded in growing highly transparent KDP crystals weighing 1280g and with dimensions 75x78x125mm^3 by platform technique (see fig.L.7.1). The growth was conducted in an indigenously designed 20 liters crystalliser and 200 liters water bath. A small KDP crystal of size ~5x5x8mm^3 was used as a seed and the growth run was conducted upto 28 days without a single nucleation and inclusion.

Second harmonic generation (SHG) elements have been prepared with maximum element size as large as 41x41x25mm^3. SHG cells have also been designed and fabricated (see fig.L.7.2). A number of KDP type-II SHG elements and SHG cells with three different aperture sizes have been prepared and supplied to several groups at CAT, BARC and some academic institutions in India. SHG conversion efficiency has been achieved as high as 31.8% without accounting for reflection losses for 151mJ/7ns Nd: YAG laser.