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

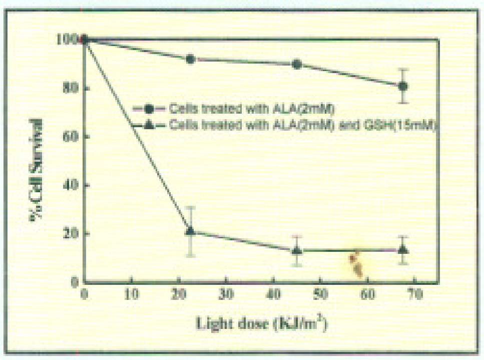

Fig.L.5.1 Survival of cells treated with ALA and irradiated with light at 405nm with and without GSH.

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.

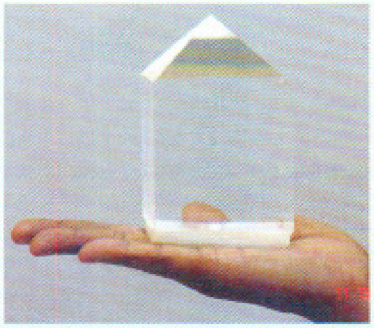

Fig. L.7.1 KDP crystal, weight 1280g, size: 756x78x135mm^3

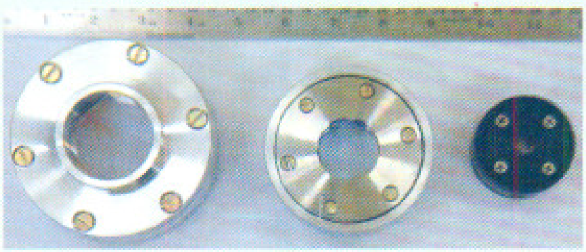

Fig. L.7.2 KDP based second harmonic generation (SHG) cells

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L.8 Laser produces better quality colmonoy cladding than GTAW

In many engineering applications surface characteristics of the components need to be modified. In the proposed 500MWe prototype fast breeder reactor (PFBR) many austenitic stainless steel components would be in contact with each other and under stress, in flowing liquid sodium environment at a temperature of 823K. Relative movements between them are also expected during reactor operation which may cause wear or self-welding of these components. In order to avoid these deleterious effects hard facing of the component is desired. It is intended to impart enhanced galling resistance to the mating surfaces to avoid self-welding. Nickel-based alloys, colmonoy are chosen in place of more widely used cobalt-based stellite alloys in order to minimize induced radioactivity in hard-faced deposits. In the case of stellite alloys, Co^{60} (a hard γ-emitter), is formed by (n, γ) reaction during reactor operation and this, in turn, exposes personnel during handling, maintenance and decommissioning of hard faced components to high level of radiation.

The colmonoy 6 deposited by gas tungsten arc welding (GTAW) has very large dilution from the austenitic stainless steel substrate. The microstructure and hardness of the colmonoy 6 deposit is significantly influenced by the dilution. For overcoming adverse effects of dilution, thicker colmonoy deposits need to be laid, which not only adds to the cost of fabrication but also induces greater distortion in the hard-faced component. Using an indigenously developed 10kW CW CO_2 laser, deposition of thin layers of colmonoy 6, with very low level of dilution from the austenitic stainless steel substrate, was established by single step laser cladding technique (fig.L.8.1). During the fast cooling cycle of laser cladding colmonoy layer is susceptible to cracking. In order to minimize cracking, laser cladding was performed on the substrate placed in a hot sand bath and subsequent cooling to room temperature was done in a controlled manner. This technique can be easily adopted for hard facing of any AISI 316L stainless steel engineering component.

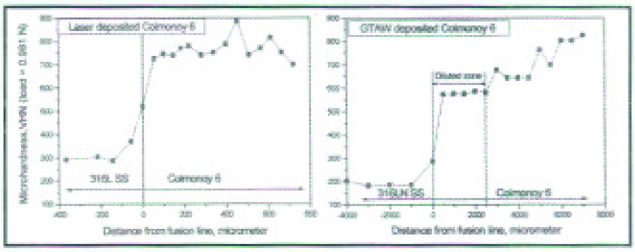

Fig. L.8.1 Comparison of hardness profiles across the cross-sections of colmonoy 6 clad austenitic stainless steel specimens.

(Contributed by: Dr. AK Nath; aknath@cat.ernet.in)

L.9 All solid-state exciter based on magnetic pulse compression technique replaces thyratron in a high repetition rate TEA CO_2 laser

High repetition rate TEA CO_2 laser is finding wide applications, such as, in selective photo-dissociation of molecules for isotope separation, paint striping for decontaminating radioactive surfaces, laser ablation for producing nanoparticles, laser marking and drilling etc. Usually thyratron based pulsed power supply is employed for exciting TEA CO_2 laser. Thyratron suffers from low operational life at high repetition rates operation due to cathode erosion and hydrogen gas consumption. An all-solid-state exciter (ASSE) using magnetic pulse compression (MPC) technique has been successfully developed for pumping a high average power and high repetition rate TEA CO_2 laser. ASSE employs a combination of IGBT semiconductor switches and magnetic switches in place of thyratron. Magnetic switch does not encounter the problem of high di/dt, high peak current and high repetition rate etc that adversely affect the lifetime of thyratron. Magnetic switch has been made using the low loss Ni-Zn ferrite cores.