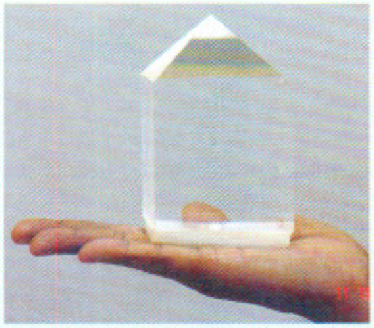

Fig. L.7.1 KDP crystal, weight 1280g, size: 756x78x135mm^3

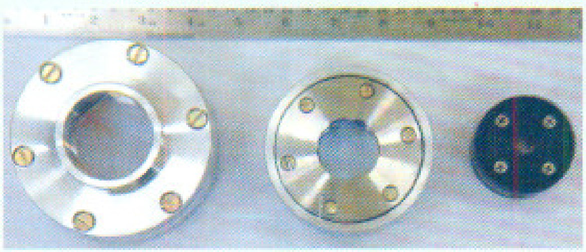

Fig. L.7.2 KDP based second harmonic generation (SHG) cells

(Contributed by: SK Sharma; sks@cat.ernet.in)

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.

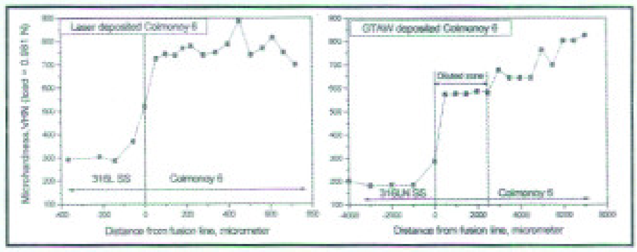

Fig. L.8.1 Comparison of hardness profiles across the cross-sections of colmonoy 6 clad austenitic stainless steel specimens.

(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.

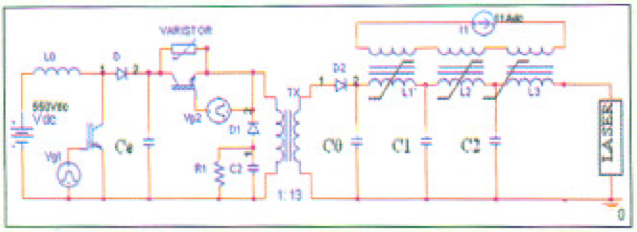

Fig. L.9.1 Circuit diagram of power supply

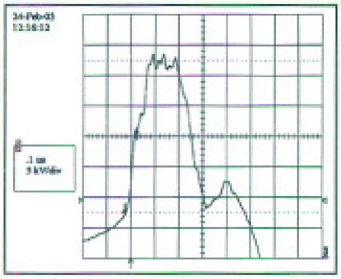

Fig. L.9.2 Voltage waveform

Max Peak Power	150MW
Output Voltage	35kV
Peak Current	3-4kA
Rise time	<80nSec
Pulse width(FWHM)	275nSec
Pulse Energy	15J
Max Repetition Rate	500Hz
Efficiency	~75%

Table 1

The electrical circuits of power supply and voltage waveform at laser head are shown in figures L.9.1 and L.9.2 respectively. The semiconductor switch produces a pulse with a rise time of 10μs and the three MPC stages compress the pulse to 75ns. Thus, a total compression gain of 125 is achieved. The input energy is regulated using a high voltage DC-DC boost converter and this stabilizes the laser output energy. The specification of ASSE is given in Table 1. The TEA CO_2 laser has been operated using ASSE at 35kV peak voltage in the range of 1 to 500Hz pulse repetition rate. It gives maximum 500W average power at 500Hz repetition rate with an electro-optic efficiency of about 8%.

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

L.10 Diffusion cooled V-fold CW CO_2 laser

A diffusion-cooled continuous wave V-fold CO_2 laser has been developed for material processing applications, which require good quality laser beam in 100-250W power range, like zero-width glass cutting. The laser with a total discharge length of 6 meters, in 4 limbs each having two discharge sections of 75cm length each, yielded a maximum output power of 260W with 12% electro-optic efficiency. This is excited by high voltage dc discharge which is superimposed on high frequency (5kHz) pulses of ~10kV peak voltage. The high frequency pulses facilitate uniform and stable discharge in 8 sections(fig. L.10.1). Because of the large resonator length (7.5meter) and small discharge tube diameter (9mm) the diffraction loss of plano-concave resonator, which is commonly used, is very large.

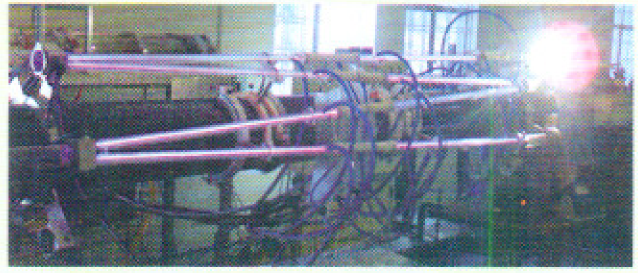

Fig. L.10.1 V-fold CW CO_2 Laser

In order to circumvent this problem a symmetric optical resonator (confocal type) has been used which is formed with all mirrors i.e. rear reflector, v-folding mirrors and zinc selenide output coupler, having 5meter radius of curvature. In this resonator, the diffraction loss is relatively less as the same laser beam propagation profile repeats in all limbs. Since the v-folding angle is within 5 degree, curved mirrors do not introduce significant astigmatism. The output beam is of 6mm diameter and its intensity distribution is near Gaussian.

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

L.11 Diode laser pumped high power Nd: YAG laser in side-pumping geometry

The development of high-power diode arrays allows the use of highly efficient diode lasers for pumping solid-state lasers. In one set up, using 5mm diameter, 100mm long Nd:YAG rod pumped by fifteen laser diode bars of 50W in an axially multiplexing scheme, we have achieved more than 215W of CW power at a diode pump power of 700W.

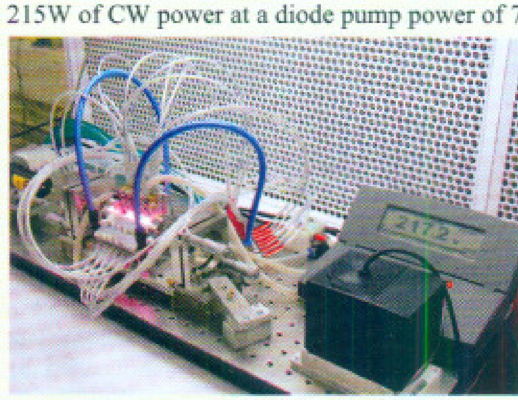

Fig. L.11. 1 The DP Nd:YAG laser