

## L.6: Development of automated system for CO<sub>2</sub> laser assisted cutting and sealing of glass tubes

CO<sub>2</sub> lasers, due to high absorption of 10.6 μm wavelength in glass, are very effective processing tool for glass. In this respect, an automated CO<sub>2</sub> laser based system has been developed for cutting and sealing of glass tubes. The system has been developed for BRIT, Mumbai for the fabrication of tritium-filled self-illuminated glass tubes. The system uses open platform based hardware and software components in its build up, providing desired flexibility to modify and upgrade it as per the need. Figure L.6.1 presents photograph of the in-house developed glass tube cutting and sealing system.



Fig. L.6.1: Glass tube cutting and sealing system.

The system consists of a 50 W sealed-off CO<sub>2</sub> laser tube, rotary stage for rotation of glass tube, linear translation stage for tube movement and vacuum pump for realizing pulling of glass tube after melting of glass by incident CO<sub>2</sub> laser beam. In the present system, the tubes are loaded one by one manually and then cutting and sealing is carried out. The whole process of movement of glass tube, its rotation, irradiation by CO<sub>2</sub> laser beam for defined time and finally pulling with the help of vacuum pump is controlled by an 8-bit Atmega2560 microcontroller based Arduino board. The various steps for automated cutting and sealing take place in an interlocked manner. The system uses an intuitive touch based human machine interface (HMI) to communicate with the main process controller for all important process events and actions for safe and hassle-free operation. The pages of HMI and control logics are developed to meet intended functional requirement of the system without violating any safety interlock conditions. The system supports jog, manual and auto; three modes of operation. The jog mode is of great use during initial testing of the system.

Here, the operator gets the freedom to move linear stage either in forward direction or backward direction and set current position as local home for stage. In manual mode, operator has the freedom to perform process related operations on his command from HMI. The auto mode is of interest during bulk production with ease. C/C++ programming language was used to develop control logics. Various safety procedures were also followed while assembling the system components. Figure L.6.2 shows magnified view of the control panel of the laser based system.



Fig. L.6.2: Magnified view of panel with control unit and camera.

The system was used to demonstrate cutting and sealing of 3 mm diameter glass tubes (length: 5 - 10 mm) with the following parameters:

- Laser power : 19 W
- Laser ON time: 7 s
- Laser spot size: 2 mm
- Rotation speed: 300 rpm

Figure L.6.3 shows photograph of some of the cut and sealed glass tube pieces.



Fig. L.6.3: Cut samples of glass tubes.

In order to test hermeticity of sealed glass tubes, helium was filled in the glass tubes and after cutting, sealing is checked with the help of helium leak detector. The cut samples demonstrated a leak rate better than  $1 \times 10^{-10}$  mbar.l/sec.

Efforts are underway to develop an upgraded version of this system, which will involve automated loading of glass tubes.

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