The processes being developed and refined include surface irradiation of potatoes to prevent sprouting, disinfestations of seeds, de-polymerisation of paper pulp sheets, curing of coatings on wood and paints for value addition.

(Contributed by: SC Bapna; bapna@cat.ernet.in)

A.15 Injector control unit for 750kV DC Accelerator

The injector control unit for 750kV direct current accelerator consists of a filament power supply, which is floating at –750kV and a beam current stabilizing unit located at ground potential. The dc accelerator uses a directly heated diode gun as an electron emitter whose filament is a 0.3mm thick thoriated tungsten wire. A dc of 7 to 9A at about 2.5V suffices the filament for its complete range of emission. The accelerating voltage for 750kV dc accelerator is generated by a 15 stage voltage multiplier stack which is fed from a 22kV high frequency ac source The filament as well as emission current values are settable from the beam current stabilizing unit and the system operates either in constant filament-current mode or in constant emission mode depending on the signal, which overrides the other. The stimulus signal for controlling the ON/OFF periods of the power control-switch is transmitted to the filament power supply through an optical fiber link. The filament power supply generates a signal whose pulse-width is proportional to the filament current. This signal is then transmitted to the current stabilizing unit through another optical link where it is further processed to realize a feedback signal for the filament current. The return current of the high voltage generator gives the feedback signal for emission current.

The filament power supply is located inside the pressure vessel and it is floating at an extra high voltage of -750kV. Hence its reliability and MTBF requirements are extremely high because the failure of a single component inside the pressure vessel will cause a great loss of effort and time of the machine. Since the reliability of a system is adversely affected with the increase in component count, the main strategy in the design of this unit has been set to minimize the number of components floating at high potential and to protect them from high voltage transients in case of an arc. To meet the set objectives, the control electronics of the filament power supply is brought out of the pressure vessel by inserting a fiber optic link between the power supply and the beam current stabilizing unit. Only power components like rectifier diodes, switching MOSFET filter inductors and capacitors are kept floating at high potential. Input ac power to the filament supply is derived using a 1200: 1 step-down ferrite core transformer and a bulk converter scheme is employed to make the current controlled switched mode power supply for the filament.

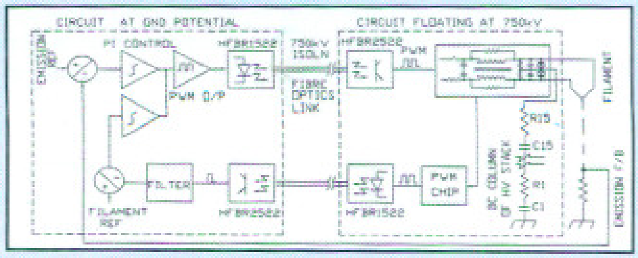


Fig. A.15.1 The schematic of the injector control unit

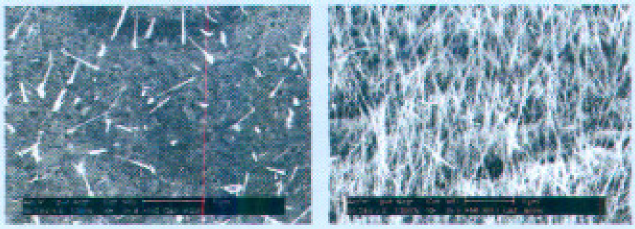
Fig. A.15.2 Filament power supply unit with high voltage dome removed

Fig.A.15.1 shows the complete schematic of the injector control unit. A high voltage dome fitted on the top of the stack provides an electrostatic shield to the filament supply unit as well as to the generator components. The output of the filament power supply is interfaced with the gun-filament through a high voltage common mode choke fitted with energy dissipating and surge arresting network consisting of glow discharge tubes and MOVs etc. The high voltage to the filament power supply is referred only at the gun end of this network with a solid copper strip of the shortest length. This helps in diverting the HV transients due to arcing in acceleration column directly to the DC column of the multiplier stack thus protecting the injector control unit. Fig.A.15.2 shows the filament power supply housing.

(Contributed by: R Banwari; rbn@cat.ernet.in)

A.16 Growth of CuO nanorods

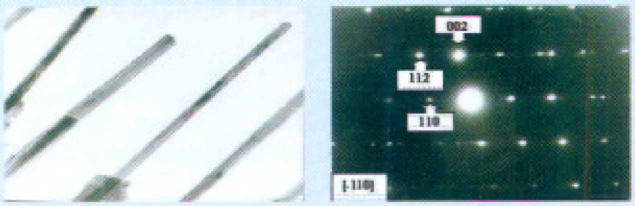
Quasi one-dimensional nanostructures, such as nanowires and nanorods have attracted great attention during past few years due to their unique physical, chemical and electronic properties and for their potential applications in the field of nanodevices, field-emitters, and catalysts. We have carried out the synthesis of CuO nanorods by annealing a commercial grade Cu foil in oxygen atmosphere at high temperature. Our investigations reveal that the aspect ratio (the ratio of length to diameter of the nanorod) and density (number of nanorods per unit area) critically depends on the growth conditions, like the oxygen flow rate, annealing temperature, annealing time, *etc.*



a b

Fig.A.16.1 SEM pictures of CuO film

A porous structure is formed in the oxide film (fig. A.16.1a). The pores have pyramid structure and act as the nucleation sites for the growth of the CuO nanorods, which grow during the process of cooling. The CuO nanorods thus produced by this method are almost unidirectional with high aspect ratio as is evident from the scanning electron micrograph shown in fig.A.16.1b; the average length and diameter of these nanorods are ~7μm and ~110nm, respectively.



a b

Fig.A.16.2 a) TEM micrograph, b) Diffraction pattern

The growth of these nanorods is perpendicular to the substrate (Cu foil) and they almost uniformly cover the complete area of the substrate. In fig. A.16.2a, we show the transmission electron micrograph of CuO nanorods. It is clear from the figure that each nanorod has a conical tip. Fig. A.16.2b shows the diffraction pattern from one of these nanorod. The diffraction pattern confirms the formation of CuO in single crystalline form.

(Contributed by: Dr. RV Nandedkar; nrv@cat.ernet.in)

A.17 Pulsed power supply for electroforming

Electroforming, i.e., building up a relatively thick layer of metal by electrochemical deposition over a base material, is a critical process for many accelerator components. In most applications, copper layer is formed over components fabricated using other metals such as - stainless steel, to meet specific functional requirements like electrical conduction, metal joining etc. Use of ordinary DC current source for this purpose is not recommended as copper thus formed, has the tendency of grains growth along with the deposit. By using periodic current reversal process (PR), a pure and smooth deposit surface can be obtained. In this process, the substrate is alternately subjected to forward (cathodic) and reverse (anodic) cycles. The properties of the deposit can be modified, by selecting optimum ratio of forward/reverse time and current amplitude. For even finer control over the process, pulsed current mode is applied using specific number of pulses with variable duty ratio in both polarities.

A switching mode power supply rated at 20V/50A has been developed for this application. The system has an off-line MOSFET bridge switching at 50kHz. The PWM regulated output after high-frequency transformer and rectifier is fed to another MOSFET bridge for polarity reversal. By means of an easy-to-use front panel control, operator can program all the parameters - number of forward and reverse cycles, base and pulse durations, and current amplitudes in forward as well as reverse mode. In view of large number of user-selected parameters, micro-controller is employed to control and generate all the timing and sequence operations. For effective utilization of the power supply for various applications involving different jobs, utmost flexibility is provided by maintaining high resolution in current amplitude and pulse duration. With the help of an active current bleeder circuit the power supply can operate in the range of minimum 0.2A to maximum 50A current, while time resolution is of the order of 1mS. The power supply is also equipped with usual protection circuits to prevent damage against probable faults such as short-circuit (fig. A.8.1). Although, the output current stability requirements are not stringent (better than ± 1%), reliable continuous operation of the power supply for many days is required in some applications, since any stoppage adversely affects the properties of deposit (fig. A.8.2). The power supply is being used in Chemical Treatment Plant.

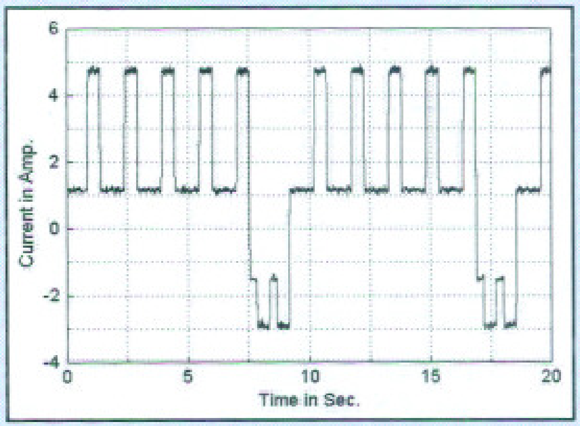


Fig.A.17.1 Typical current cycle