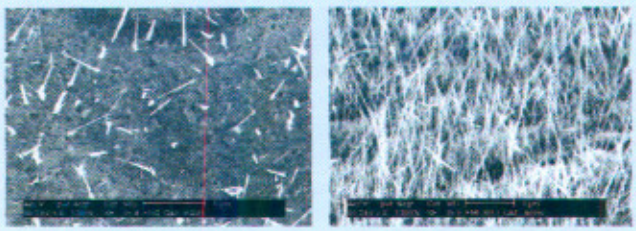
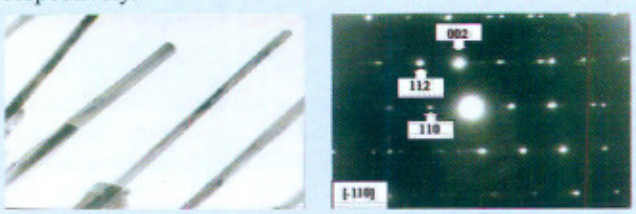
(number of nanorods per unit area) critically depends on the growth conditions, like the oxygen flow rate, annealing temperature, annealing time, *etc.*



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.

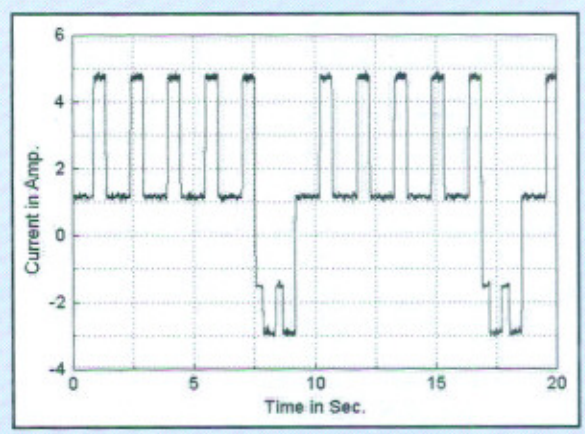


Fig.A.17.1 Typical current cycle

Fig.A.17.2 Photograph of the power supply

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A.18 Four channel ADC board for Indus-2 beam position indicator (BPI) interface

A four channel sampling ADC board for BPI (Beam Position Indicator) interface has been developed for controls related to Indus-2 beam diagnostic sub-system. The salient features are:

- A24, D16 VME Slave
- 4 independent channels of 16-bit, 100 KSPS sampling serial-ADCs
- 4 digital-input channels for reading status
- Onboard DC-DC converters for local isolated power
- Provision for using separate external power source for ADC portion
- Selectable input range: (0-10 V) or (-10 to +10 V)
- Two stage low-pass filter at each input channel.
- Optical isolation from VME bus
- Selectable, interrupt based data transfer control
- Jumper and switch selectable interrupt level and vector ID
- External trigger can be enabled by software to start conversion and generate interrupt
- Facility to read back the conversion status of each ADC
- All the ADC data handling, VME address decoding and interrupt logic implemented in the on-board CPLD

(Contributed by: P Fatnani; fatnani@cat.ernet.in)

A.19 Reed RGA, the partial pressure analyzer for Indus-2 vacuum control

Partial pressure monitoring is important for knowing status of vacuum in the Indus-2 ring. This is done using the residual gas analyzers (RGA). There are 16 RGA units, which will be kept in different places in Indus-2 ring for partial pressure monitoring. The software takes data from field instruments over RS 422 link using DDE between software modules. The data logging of partial pressure and alarm information, generated in the event when partial pressure deviate beyond the set point, was required. The software provides user-friendly controls and scheme for filament protection. It also provides easy setting of 192 channels for different mass number of gas. It provides panels for setting high and low alarm along with hysteresis band, accuracy, and data log rate, log file name, audio and visual alarm indications, user name and event log, user permission etc.

Reed RGA provides easy approach of click over diagram, to view partial pressure of gas in any part of Indus-2. Tabular display of partial pressure provides data display of 16 RGA units on single panel. User name logging and event log feature helps in ensuring instrument protection and fault finding in hardware. Diagnostic controls are also provided which helps the user in changing the unit name and location online, lock-unlock 'RGA for windows' software module, trigger RGA unit, scan progressing etc.

(Contributed by: P Fatnani; fatnani@cat.ernet.in)

A.20 10MeV, 10kW Electron linac for food irradiation applications

The 10MeV, 10kW electron linear accelerator facility for food irradiation applications has been developed (fig. A20.1). The most crucial and challenging subsystem of the LINAC, the 6MW peak power 25kW average power microwave system has been designed, developed and tested. The 6MW peak power and 25kW average power multi-beam klystron having permanent magnet focusing system is energized by a 55kV, 270A pulse modulator. A line type modulator for 15MW peak and 70kW average power capability has been developed. The microwave system is tested on a microwave load for full RF pulse width of 12.5 microseconds at 150Hz repetition rate and testing is underway upto 300Hz. The rise time of the modulator pulse is 700 nanoseconds for pulse duration of 14 micro sec with flat top variations less than ±1%. The microwave power level flat top variations have been achieved to be within ±0.1dB. The modulator has been connected to the electron gun equivalent impedance and the output pulse has been tuned for the klystron impedance as well as the gun impedance. The electron structure has been received from Russia. Magnet power supplies, safety interlock system, access control system using Cori lock has been designed, installed and tested. Commissioning of the LINAC will commence after getting the approval from AERB.