A.7 Development of System for Synchrotron Optics Cleaning

Synchrotron optical elements are used in high /ultra-high vacuum environment. Even in this environment, carbon contamination is practically unavoidable in the presence of intense x-ray synchrotron beam. Generally, synchrotron mirrors are coated with materials like gold to get high reflectivity. Carbon contamination decreases the reflectivity. A RF plasma system, based on cleaning by oxygen plasma has been developed and tested for a glass substrate coated by carbon soot as well as by vacuum evaporation of carbon.

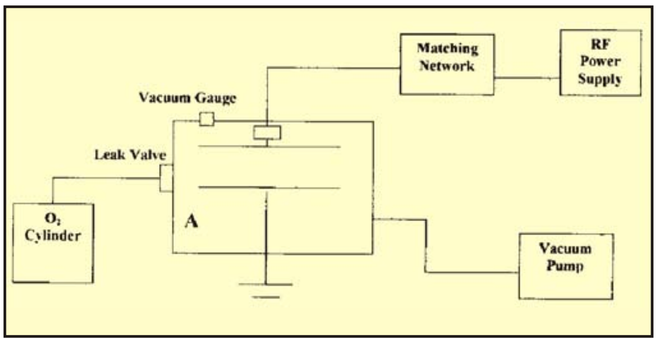
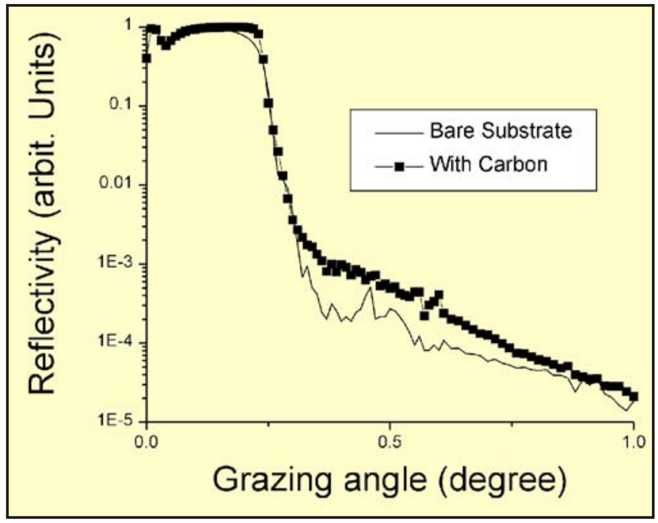


Figure.A.7.1 shows the schematic of the synchrotron optics cleaning system. RF supply is applied between parallel plates of a capacitor (Rectangular geometry of area 300mm x 500mm and gap 10mm), through an impedance matching network (impedance of 50 ohms). Maximum power output of 50W, at a frequency of 27.12 MHz has been used. A dual power meter is used to measure the forward as well as the reflected power. The powered electrode is isolated from the SS chamber by Teflon rod. The lower electrode is grounded. Oxygen cylinder supplies pure oxygen and the flow rate is adjusted using an all-metal precision leak valve. The vacuum chamber is pre-evacuated to a pressure of 10^{-7} Torr using a turbo-molecular pump. TMP is then switched off and the system is evacuated using a rotary pump, during the plasma is on. A pressure of 0.1Torr to 10 Torr is used during cleaning. For the results shown, the cleaning has been performed for 12 hours.

Hard x-ray reflectivity of float glass substrate and float glass substrate coated with vacuum evaporated carbon film are shown in fig. A.7.2. X-ray reflectivity after oxygen plasma treatment almost merges with that of the substrate. Hence, cleaning is satisfactory. A gold coated substrate after cleaning showed that there is no damage to the gold coating, as measured by transmission of visible, near IR spectrum.



(Contributed by: A.K. Sinha; anil@cat.ernet.in)

A.8 Series Testing of Superconducting Magnets using SC Switch

Superconducting Technology Lab, Magnet Division is engaged in manufacturing & testing of large number of Superconducting (SC) Corrector magnets for the LHC projects at CERN. The magnets undergo a series of qualification tests prior to the shipment. One of the important tests is cryogenic training at 4.2 K under LHe by powering them to rated test current. Conventionally, in order to train 'n' number of magnets, 'n+1' number of current leads are required to charge them when connected in parallel. This results in high static heat load, as current leads are the major source of heat leak in to the cryostat. Also the testing in such scheme is quiet cumbersome requiring change of lead terminals externally each time. The initial testing capacity with this scheme was up to six magnets per day using seven current leads with one as common.

Apparently, each magnet is also fitted with a SC switch in parallel for measuring the contact resistance (coil joints) of the magnet. We designed an innovative scheme by connecting the magnets under test in "*series*". The current flow is controlled using SC switch, to be able to test the particular magnet. In principle, just two current leads are required in this scheme, however we have taken three current leads with two circuits of six magnets each to avoid problem of maintaining LHe level for immersion of magnets.

Fig.A.8.1 Showing 12 magnets on the test insert

The scheme has been successfully tested and implemented for testing 12 magnets at a time (fig.A.8.3). The scheme allows measuring the contact resistance of all the magnets simultaneously thereby reducing total testing time further. With this, LHe consumption has been reduced by 25% and a throughput of 12 magnets/day has been achieved.

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A.9 The DAE-CERN Collaboration for the Testing and Evaluation of Super-conducting Magnets of the LHC

The DAE-CERN Collaboration for the LHC Project at CERN foresees up to nearly 100 man-years of manpower for the LHC Magnets test Programe. Under this protocol, Engineers and Physicists from India participate in the testing and qualifying the main dipoles of the LHC. The 1232 super-conducting main dipoles help in deflecting the 7 TeV beams in the LHC. The Indian Collaborators will soon help in testing the ~500 Short Straight Sections (SSS) too, which house the focusing quadrupoles, apart from several super-conducting corrector magnets.

LHC employs superconducting dipoles to produce fields of 8.33 Tesla, which requires a current of 11850A, possible under the cryogenic regime of super-fluid helium at 1.9 K. Every magnet has to be "trained" before putting into the tunnel. This requires training of the magnets through a sequence of quenches. The "trained" magnets are normally expected to have "memory" meaning that they maintain their performance after testing & storage and before their installation in the tunnel.

An extensive test facility for both the dipoles and the SSS, is available in CERN. Apart from equipment for cooling and powering the magnets for training, SM18 has facilities for making extensive magnetic measurements, both when the magnets are cold or warm. The magnetic measurements include the measurements during LHC magnetic ramp simulation cycle as well as the so-called load line, and the field-angle measurements. SM18 Test Facility has six clusters, each with two test benches. Each bench is fed independently with a cryogenic feed box (CFB). The benches in a cluster share common electronics and the power source. This means that at any time only one bench in a cluster can undergo cold tests within the limits of cryogenic availability. A number of scientists and engineers from CAT have contributed to the magnet evaluation Programe. Dr. V. Chohan of CERN heads the SM18 Facility Operation for Cold Tests.

On the initiative and under the guidance of the operation team leader, a number of new features to aid operation have been brought in and significant improvements have been carried out over the past two years. Indian team members and CERN staff have been involved in these new features as well as carrying out these improvements, which have immensely helped in achieving a throughput of around 11-12 magnets every week. This performance is necessary to achieve the target date of 2007 for the start-up of the LHC. The whole process of Operation for magnet testing has undergone a renaissance from a crude manual data logging into a more efficient, sophisticated and highly automated testing management system in a rather smooth manner.

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