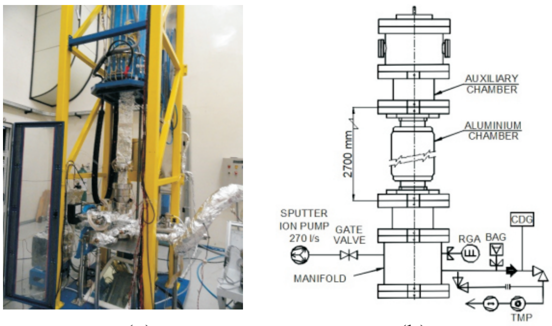
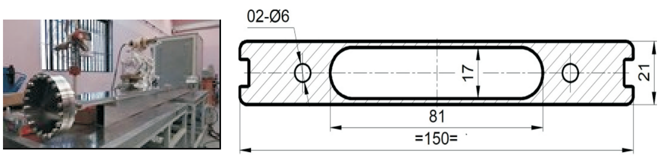
A.7: UHV performance of NEG coated race track profile vacuum chamber for Indus-2 undulator

Three undulators (U1, U2, and U3) have been deployed in Indus-2 to generate photons in specific energy ranges with higher flux for dedicated beamlines. The synchrotron radiation (SR), coming out from these undulators is much brighter than the SR from the bending magnet. Due to smaller pole gap in undulator, internal cross section of vacuum chamber has been reduced to 81 mm × 17 mm resulting to a very low conductance of 2.2 l/s. Therefore, it is very difficult to achieve ultra-high vacuum (UHV) condition with conventional pumping. In order to obtain a longer beam lifetime, in presence of the stored beam current of 200 mA at 2.5 GeV, vacuum level of ~1×10^{-9} mbar is required in the chamber. For generating UHV condition in such low conductance chamber, an advanced non-evaporable getter (NEG) pumping is required. NEG coating (Ti-Zr-V) alloy onto internal surface of vacuum chamber acts as distributed UHV pump in activated condition. Presently, NEG coated chambers installed with the undulators are imported. To achieve the self-reliance in such advanced technology for our accelerator programme, efforts were made to indigenously develop such NEG coated chambers. One 2700 mm long chamber of AA6063-T6 material, coated with NEG using in house developed DC magnetron large coating setup (Figure A.7.1), has been developed as a spare chamber for undulator. Photograph of vacuum chamber and its cross section are shown in Figures A.7.2.



(a) (b)

Fig. A.7.1: (a) Coating setup with vacuum chamber, and, (b) schematic of ultimate vacuum test setup.



(a) (b)

Fig. A.7.2: (a) Photograph, and, (b) cross section of vacuum chamber.

NEG coating was applied with pre-optimized process parameters to achieve ~ 0.8 µm thick coating of Ti-Zr-V ternary alloy, uniformly along the length and 5.2×10^{-10} mbar ultimate vacuum was achieved. Improvement in vacuum in as-coated condition is attributed to diffusion barrier action of coated film. Subsequently, coating was subjected to activation at 180 °C for 24 hrs and ultimate vacuum was further improved with significant reduction of partial pressure (PP) of CO and H_2O. Ultimate pressure, PP of CO and H_2O at different stages are given in Table A.7.1.

Table A.7.1: Ultimate vacuum performance of chamber in different conditions.

Parameter		Uncoated, unbaked condition	Uncoated & baked condition	Coated condition	Activated condition
Ultimate pressure (mbar)		4.7×10^{-9}	2×10^{-9}	5.2×10^{-10}	2.4×10^{-10}
PP of gas	CO	5×10^{-9}	4×10^{-10}	2×10^{-10}	4.0×10^{-12}
	H_2O	9×10^{-9}	5×10^{-10}	1.5×10^{-10}	$<1\times10^{-12}$

Main residual gases present after NEG activation were H_2 and CO as shown in Figure A.7.3. UHV condition achieved both in terms of ultimate pressure and quality makes the Al alloy NEG coated chamber qualified for its deployment inside the undulator in the Indus-2 ring.

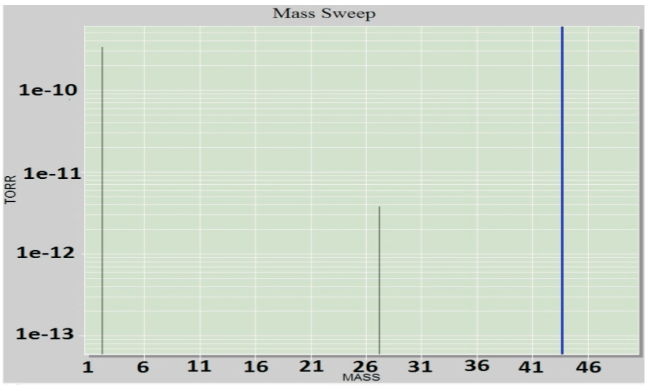


Fig. A.7.3: RGA spectrum of NEG activated chamber.

Development of this field deployable NEG technology will serve major import substitute for building the NEG coated UHV chambers for future high brilliance synchrotron radiation source and accumulator ring of Indian Facility for Spallation Research.

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