A.7: Non-evaporable getter (NEG) coating of small aperture aluminium alloy 6063-T6 chamber and its characterization

Non-evaporable getter (NEG) is the ternary alloy of getter elements Ti, Zr and V. NEG coating is very useful to pump the insertion device (undulator) chambers in the storage ring. In UHVTS the inner surface of vacuum chamber made of aluminium alloy having 17 mm x 81 mm race-track aperture and 300 mm length was coated with the NEG material along with the flat samples of glass and aluminium. The objective of this experiment was to standardize the process parameters for future coating of spare undulator chambers for their application in Indus-2 storage ring.

The vacuum characterization of NEG coated chamber was carried out by ultimate vacuum testing and thin film characterization was done by stylus profilometer, SIMS and SEM for thickness, composition and surface morphology studies respectively. Salient features of NEG thin film coating are simplified vacuum chamber design, low photon induced desorption yield, low secondary electron yield, low thermal outgassing rate and low ultimate pressure in small aperture vacuum chambers.

A UHV compatible cylindrical DC magnetron sputtering system (Figure A.7.1) in UHV lab was used to coat the aluminium chamber.

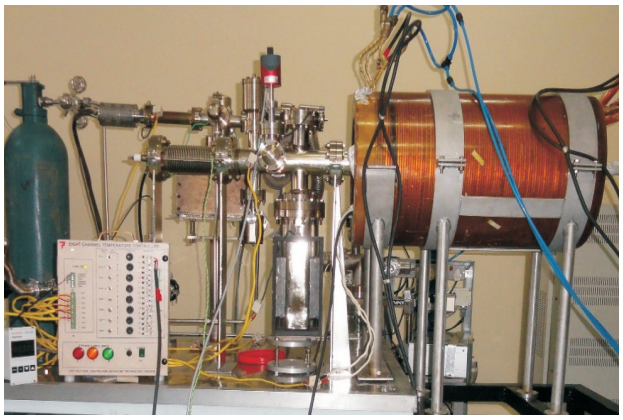
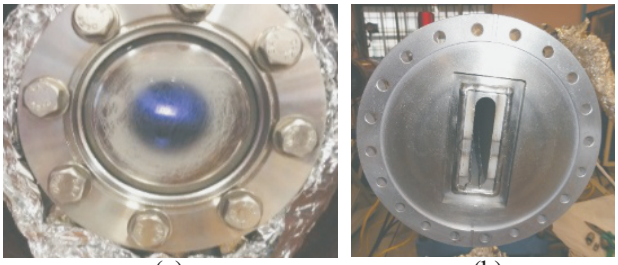


Fig. A.7.1: DC Magnetron sputter deposition system.

The aluminium chamber was NEG coated using double targets to get the uniformity of thin film in race-track profile vacuum chamber. This target was prepared by intertwisting Ti, Zr and V wires in the ratio of 1:1:1 and sputtered cleaned before assembly in the coating setup. Coating process parameters are 600 V discharge voltage, 100 mA discharge current, 1.5×10^{-3} mbar argon gas pressure, 400 gauss magnetic field and substrate temperature of 100 °C. Solenoid was used to enhance the ionization at low pressure. During coating, visible discharge is shown in Figure A.7.2(a). After coating inner surface of the vacuum chamber become grayish in color as shown in Figure A.7.2 (b).



(a) (b)

Fig. A.7.2: (a) Visible discharge during coating and (b) End view of chamber after NEG coating.

The vacuum characterization was carried out by the ultimate vacuum testing of aluminium chamber at different stages. Before coating, the ultimate vacuum achieved in coating system was 1.2×10^{-9} mbar using sputter ion pump (SIP) of 70 l/s and after coating it was improved to 5.5×10^{-10} mbar in as coated condition. Subsequently the NEG coated chamber was activated by heating it at 180°C for 24 hours and finally 3×10^{-11} mbar ultimate vacuum was achieved by NEG pumping. Activation of NEG film is carried out to remove the oxide layer and generate a fresh chemically active layer for efficient pumping. The chemical composition of NEG coating (in at%) achieved was Ti- 27%, Zr- 33% and V- 40%, thickness achieved was about 3 µm for 6 hours coating duration. Figure A.7.3 shows the surface morphology of the film coated on as-extruded aluminum substrate was quite rough which provide good absorption sites.

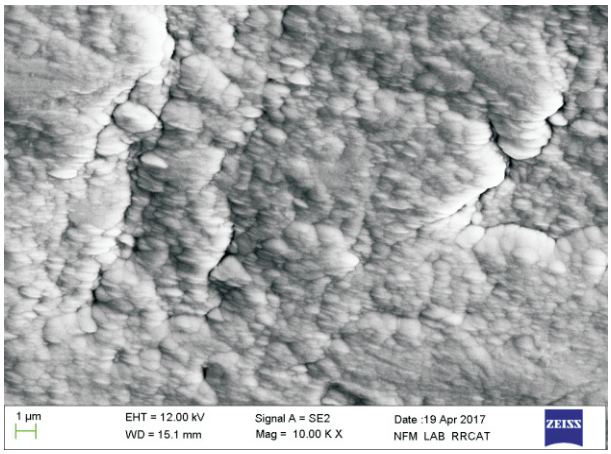


Fig. A.7.3: Morphology of deposited NEG film on as-extruded aluminum substrate.

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