A.6: Deposition of Ti-Zr-V based thin films using different sputtering gases (Ar and Kr) and their characterization

Non evaporable getter (NEG) coating is proposed to be an improved method to decrease the thermal outgassing of the vacuum chamber and provide conductance free pumping inside the low gap vacuum chamber. In Indus-2 synchrotron radiation source, at present three undulator chambers were installed to get the high brightness radiation. The inner wall of the aluminium vacuum chambers were deposited by Ti-Zr-V material by SAES Getters from Italy. The benefits of this coating is to provide uniformly distributed pumping in the narrow and long vacuum chambers. Therefore, to develop the NEG coated vacuum chambers in-house, NEG coating parameters optimization work is going on. Present article describes about the NEG thin film deposition using the different sputtering gases viz. Ar and Kr and their characterization.

The NEG film was deposited inside the elliptical aluminium chamber using an in-house developed DC magnetron sputtering system. The system details are given in RRCAT Newsletter Vol. 31(1) 2018. Two aluminium chambers (AA6063-T6) of dimension 17 mm x 81 mm and 400 mm long were ultrasonically cleaned using iso-propanol (IP) just before NEG coating. Small glass samples and aluminum samples of dimension 10 mm x 10 mm (called as samples A3 and A4) were also kept inside the extension chamber to deposit the film at same parameters. The surface roughness (Ra) of both the chambers and samples was in the range of 0.3 to 0.4 µm.

In order to study the behavior of NEG coated chambers, they were tested for ultimate vacuum after activation at 180 ºC temperature for 24 hrs and subsequent pumping. The NEG coated specimens were analyzed by SEM-EDS for elemental composition and surface morphology. Coating thickness was measured by mechanical stylus profile-meter (Alpha-Step IQ-KLA-Tencor) and crystallinity of film by XRD analysis. Adhesion of the film to the substrate was tested as per ASTM D3359 standard. The glass samples were used to estimate the thickness of film and extruded aluminium samples were used to investigate the surface morphology, crystalline structure, surface elemental analysis and adhesion.

Two aluminium chambers were deposited using Ti-Zr-V intertwined target with following parameters: discharge voltage: -600 V; magnetic field: 400 G; substrate temperature: 100 ºC; and discharge current: 100 mA. Two separate coating cycles were carried out independently using Ar gas at 2.7×10^{-2} mbar pressure and using Kr gas at 1.8×10^{-2} mbar pressure respectively, with all other parameters same.

After deposition, the vacuum performance of the NEG coated chamber was studied by means of ultimate vacuum. NEG films deposited with both the sputter gases (Ar, Kr) were activated at 180 ºC for 24 hrs. Subsequent pumping resulted in achieving ultimate vacuum in the range of 10^{-11} mbar.

The film thickness, composition, adhesion details and the ultimate vacuum testing results of the NEG coated vacuum chambers for different sputtering gases are given in Table A.6.1.

Table A.6.1: Characterization results of NEG thin films.

Sputtering gas	Ar	Kr
Film thickness	500 nm	280 nm
Composition (Atom %)	Ti- 33%, Zr-31%, V-36%	Ti- 32%, Zr-25%, V-43%
ASTM D3359 Adhesion test results	ASTM class 4B standard passed	ASTM class 5B standard passed
Ultimate Vacuum	4.8×10^{-11} mbar	3×10^{-11} mbar

X-ray diffraction measurements of samples coated using Ar as sputtering gas shows the crystalline nature of the film (Figure A.6.1).

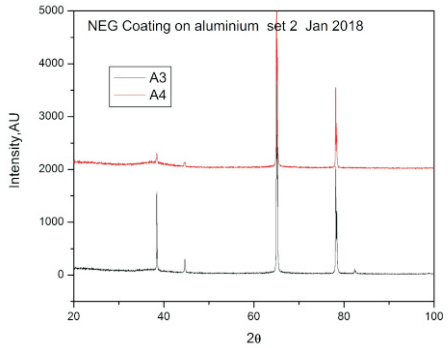

Fig. A.6.1: XRD patters of two specimens, A3 and A4, deposited using Ar as sputtering gas.

The compositions of the thin films obtained with both the sputter gases (Ar, Kr) are in lower activation temperature range. The results show that the Ti-Zr-V thin film deposited with Kr sputtering gas has good adhesion and better vacuum performance as compared to the film deposited with Ar sputtering gas. This work was a collaborative effort of UHVTS and MSG/LMPD.

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