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Photon Stimulated Desorption of Neutral Species from Aluminum*

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I. INTRODUCTION

Photon Stimulated Desorption of neutral species (PSD) is the major dynamic gas load in electron synchrotron light source. In the National Synchrotron Light Source, PSD presented initial machine commissioning difficulty. Sensitivity to surface contamination on PSD had been experienced during an incident of Pumblin Oil contamination[1].

U10B-Photon Stimulated Desorption Experimental Station is constructed to investigate: 1 - the degree of the contribution to the photon stimulated desorption (PSD) from primary photon flux and scattered secondary photon flux, 2 - the underlying mechanism for photon stimulated desorption, 3 - criteria to chose the proper beam tube material for future a accelerator such as the Superconducting X-Ray Lithography Source (SXLS), Free Electron Laser (FEL), Superconducting Super Collider (SSC), Advanced Light Source (ALS)... . In this report, only photon stimulated desorption of neutral species (PSD) from aluminum with different surface treatments is reported to show the great potential for this station to investigate beam tube material selection.

General consensus on the underlying mechanism of PSD in operating electron synchrotron light source can be found in literatures [2,3,4]. Many attempts to elucidate the PSD mechanism fail due to either lack of experimental data or insufficient instrumentation[5]. With further instrumentation and monochromator, this station is capable to shed the light on PSD underlying mechanism.

II. EXPERIMENTAL

PSD experiments are carried out in U10B beam line of the VUV ring at the NSLS. Three electrically isolated samples located 120 degrees apart on a rotating drum in the UHV chamber. Figure I-a, shows an exploring view of experimental set-up of U10B PSD Experimental Station. The main UHV vacuum chamber is mounted on the top of an aluminum platform which can be rotated 5° in a horizontal plane. The station is capable to be baked to 300° C. An all metal gate valve is used so that the station can be pretreated before installation in the beam line and sample surface can be treated in- situ in the beam line. a 5 mils titanium wire, which can be retracked from the light path, is used for in-situ glow-discharge surface treatment. A rotating drum, composed of high precision ball bearings and Beryllium-copper worm gears, provides a mechanism to interchange three sample positions in vacuum. After the system is evacuated to pressure less than 2×10^{-9} Torr, the station is then pivoted to let sample 1 intercept the incoming photon to the maximum extent with certain aperture setting. Figure I-b shows the general experimental lay-out. The primary photon strikes at sample 50 milliradian grazing angle and covers about 100 square centimeter. PSD vs. photon dosage start with low current at low dosage (300ma or less for 4 hours) and ends up with total dosage of 10 ampere-hours. Only quadrupole mass spectrometer is used since CO_2 decomposed by Bayard-Alpert gauge has been noticed [6].

III. RESULTS & DISCUSSION

Table I. shows the results of PSD yield (with arbitrary units) of 6063 Aluminum with three different treatments. Al-1 is 6063 Aluminum alloy with NSLS standard cleaning treatment. Water PSD desorption after 150° C 48 hours baked is an artificial fact from a minute air leak during bake-out. Al-2 is Al-1 oxygen glow discharge treated from 1 ampere-hour in-situ after it received 10 ampere-hours photon dosages. The dramatic decrease in PSD of every species by oxygen glow-discharge implies surface plays an important role in PSD underlying mechanism. Al-3 is Al2 wetted with moisten atmosphere after it receives 10 ampere-hours photon dosage. Fig. II-a,b show the initial PSD Mass Spectra from Al-2 and Al-3 respectively. Additional high oxygen PSD yield as shown in Fig. II-b is believed a surface reaction channel stimulated by synchrotron white light created by oxygen glow-discharge. Further investigation equipped with surface instrument is proposed.

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DISCLAIMER

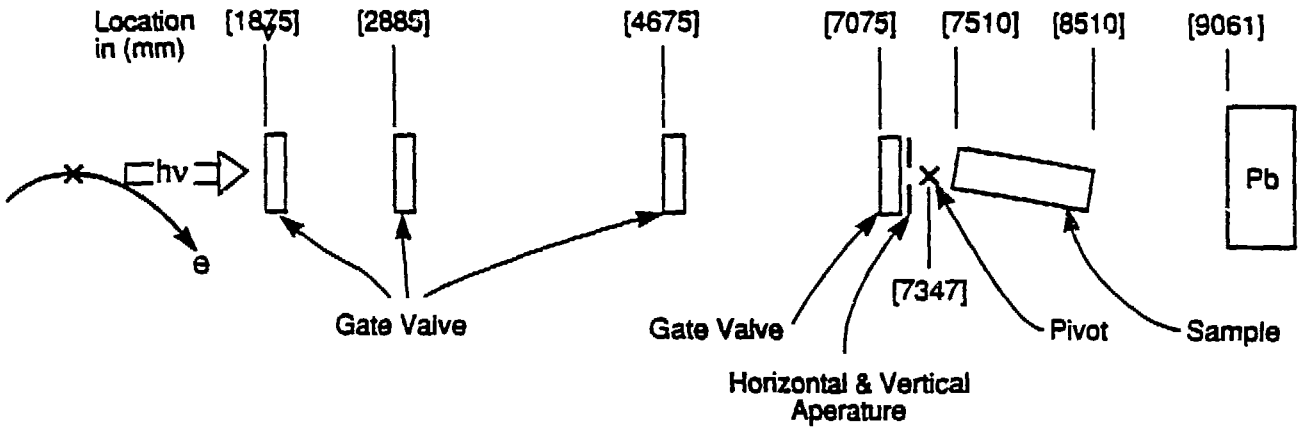

Fig. 1-b Experimental Lay-out for this Experiment at the VUV Ring of National Synchrotron Ligh Source.

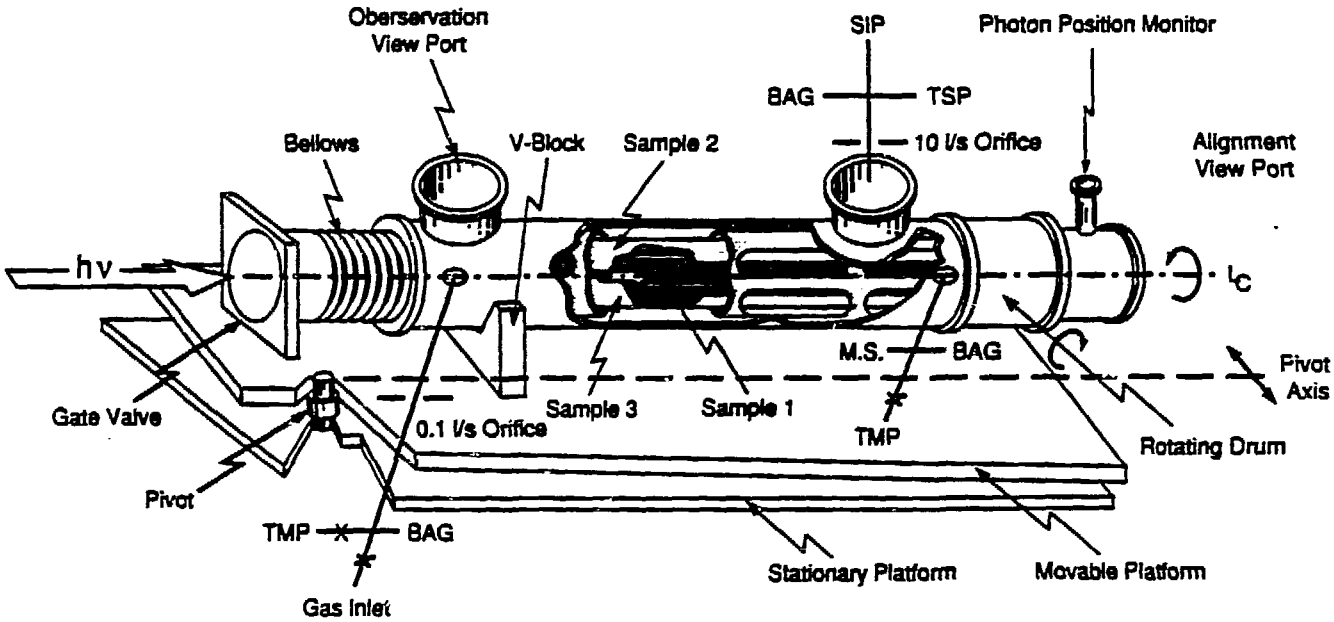

Fig. 1-a UIOB Photon Stimulated Desorption Experimental Station
BAG: Bayard- Alpert Guage; SIP: Sputter Ion Pump; TMP: Turbomolecular Pump;
TSP: Titanium Sublimation Pump; M.S.: Quardropole Mass Spectrometer.

IV. ACKNOWLEDGMENT

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V. REFERENCE

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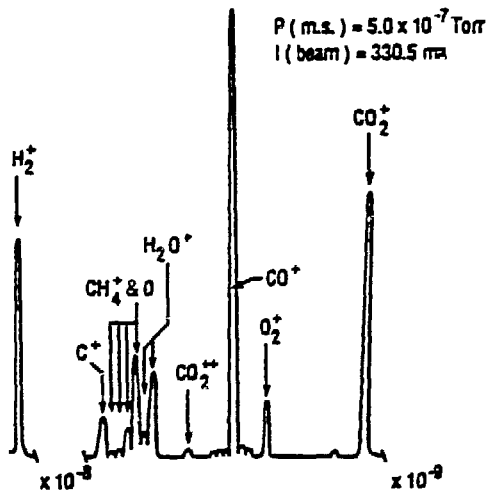

Fig. II - b The initial Photon Stimulated Desorption Mass Spectrum of 6063 aluminum taken after two weeks of air exposure. The aluminum samples were treated with 1 A-H oxygen glow discharged and 10 A-H synchrotron radiation.

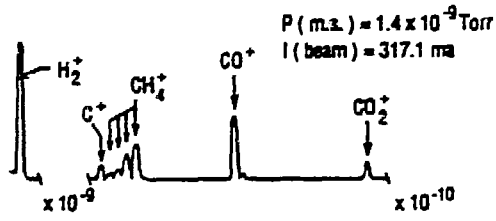

Fig. II - a The initial Photon Stimulated Desorption Mass Spectrum of 6063 aluminum taken after 1 A-H oxygen glow discharged treatment.

TABLE I
PHOTON STIMULATED DESORPTION (TORR/AMP) OF
6063 ALUMINUM
WITH DIFFERENT SURFACE TREATMENT

Outgassing Species	Dosage (Ampere-Hours)		
	0.1	1	10
Al-1			
H_2	1.00×10^{-6}	3.16×10^{-7}	1.00×10^{-7}
CH_4	1.24×10^{-8}	3.03×10^{-9}	7.11×10^{-10}
H_2O	2.31×10^{-8}	5.06×10	1.11×10^{-9}
CO	2.35×10^{-7}	5.74×10^{-8}	1.60×10^{-8}
C_2H_4	7.74×10^{-9}	1.67×10^{-9}	3.49×10^{-10}
Ar	3.24×10^{-9}	6.31×10^{-10}	1.29×10^{-10}
Al-2			
H_2	1.08×10^{-8}	4.14×10^{-9}	2.15×10^{-9}
CH_4	5.84×10^{-11}	1.41×10^{-11}	5.01×10^{-12}
H_2O	4.19×10^{-12}	1.43×10^{-12}	4.41×10^{-13}
CO	4.47×10^{-10}	1.53×10^{-10}	6.56×10^{11}
O_2	4.19×10^{-12}	1.43×10^{-12}	4.41×10^{-13}
CO_2	3.98×10^{-11}	7.08×10^{-12}	1.58×10^{12}
Ar	4.19×10^{-10}	1.43×1^{-12}	4.41×10^{-13}
Al-3			
H_2	3.98×10^{-7}	1.78×10^{-7}	6.11×10^{-8}
CH_4	1.41×1^{-9}	6.31×1^{-10}	1.63×10^{-10}
H_2O	2.98×10^{-8}	9.26×10^{-10}	1.63×10^{-10}
CO	3.55×10^{-8}	1.45×10^{-8}	3.55×10^{-9}
O_2	1.51×10^{-8}	1.18×10^{-8}	3.98×10^{-9}
CO_2	1.47×10^{-8}	4.34×10^{-9}	7.50×10^{-10}
Ar	nil	nil	nil