Thursday Afternoon Poster Sessions

Vacuum Technology

Room: 4C - Session VT-ThP

Vacuum Technology Poster Session (including Student Poster Competition with Cash Award)

VT-ThP1 Design and Construction of a Vacuum Tube Furnace with High Voltage Field for the Growth of Silicon Nanowires, ***C.A. Adams***, *J.J. Register*, University of South Florida

Construction of a Vacuum Tube Furnace with High Voltage Field for the Growth of Silicon Nanowires. The goal of this project is to build a vacuum tube furnace providing up to 1150 degrees Celsius in a vacuum of approximately 30 mTorr and an electric field of 5V/μm in density to the sample. Feed and purge gasses will need to be fed through into the chamber. The tube furnace will be constructed of a ceramic cylindrical heater element mounted in a stainless steal housing with carbon board insulation surrounded. The tube will be Quartz approximately 12.5 cm diameter and 122 cm long and 2.4 cm thick with an open end and the other end reducing to a 3/8 inch tube. A stainless steal termination will be designed and built to provide a vacuum seal to the open end of the tube. This termination will use viton gasket compression seal and end in a vacuum door. All feedthroughs will take place through the side walls of the termination collar. The vacuum system will consist of a two stage mechanical pump with a foreline trap and a thermocouple vacuum gage. MKS vacuum gage and mass-flow controllers will be integrated with Labview for operational programming and data recording. Labview will also be used to record the high voltage run time and values, control and record the temperature. The furnace heater element will be powered by an Omega PID controller coupled with a SSR.

VT-ThP2 Experimental Measurements of Thermal Accommodation Coefficients for Microscale Gas-Phase Heat Transfer, *W.M. Trott, D.J. Rader, J.N. Castañeda, J.R. Torczynski, M.A. Gallis*, Sandia National Laboratories, ***L.A. Gochberg***, Novellus Systems, Inc.

An experimental apparatus is described that measures gas-surface thermal accommodation coefficients from the pressure dependence of the conductive heat flux between parallel plates separated by a gas-filled gap. Heat flux between the plates is inferred from measurements of temperature drop between the plate surface and an adjacent temperature-controlled water bath. Thermal accommodation coefficients are determined from the pressure dependence of the heat flux at a fixed plate separation. The apparatus is designed to conduct tests with a variety of gases in contact with interchangeable, well-characterized surfaces of various materials (e.g., metals, ceramics, semiconductors) with various surface finishes (e.g., smooth, rough). Experiments are reported for three gases (argon, nitrogen, and helium) in contact with pairs of 304 stainless steel plates prepared with one of two finishes: lathe-machined or mirror-polished. For argon and nitrogen, the measured accommodation coefficients for machined and polished plates are near unity and independent of finish to within experimental uncertainty. For helium, the accommodation coefficients are much lower and show a slight variation with surface roughness. Two different methods are used to determine the accommodation coefficient from experimental data: the Sherman-Lees formula and the GTR formula. These approaches yield values of 0.87 and 0.94 for argon, 0.80 and 0.86 for nitrogen, 0.36 and 0.38 for helium with the machined finish, and 0.40 and 0.42 for helium with the polished finish, respectively, with an uncertainty of ±0.02. The GTR values for argon and nitrogen are generally in better agreement with the results of other investigators than the Sherman-Lees values are, and both helium results are in reasonable agreement with values in the literature.

VT-ThP3 Sputter Deposition System for High Throughput Fabrication of Composition Spreads, ***J.M. Gregoire***, *R.B. van Dover, J. Jin, F.J. DiSalvo, H.D. Abruna*, Cornell University

We describe a custom built sputtering system that can deposit composition spreads in an effectively UHV environment but which does not require the high-throughput paradigm to be compromised by a long pumpdown each time a target is changed. The system employs four magnetron sputter guns in a cryoshroud (getter sputtering) which allows elements such as Ti and Zr to be deposited with minimal contamination by oxygen or other reactive background gasses. The system also relies on custom substrate heaters to give rapid heating and cooldown. The effectiveness of the gettering technique is evaluated, and example results obtained for catalytic activity of a pseudoternary composition spread are presented.

VT-ThP4 How Does One Turn a Research-Based Molecular Beam Epitaxy System into a Reliable Training Tool?, ***M.-R. Padmore***, *E.I. Altman, V.E. Henrich, F. Walker*, Yale University

Electronic devices are simultaneously decreasing in size while increasing in their importance to our everyday lives. Thin film crystalline growth is necessary for the production and integration of micro- and nanoelectronics. The Molecular Beam Epitaxy (MBE) system is one of the most widely used methods of achieving this growth. As such, it is valuable to train students in the use and applications of MBE as early as at the undergraduate level. However, in using the system to train less-experienced users, the chance of system failure increases dramatically. Thus, a system must be built which can, through the use of preventative interlocks and user-friendly interfaces, easily and cost-effectively be incorporated into an instructional setting. A major problem with many preventative measures is that they are implemented using administrative and/or procedural controls. These types of controls block the transparency of the process by not allowing the students to interact with the system itself. This system is designed to be "hands-on", allowing the trainees to see the basic science behind the technology they are using, without reducing the reliability of the system. By using engineering controls such as automatic valves and computerized shutdown interlocks, the main failures which arise from: a.) the sample transfer mechanism; b.) the ultra-high vacuum requirements; and c.) the water cooling requirements; can be avoided without severely decreasing the transparency of the system's process and with an increase in ease of use. An evaluation of the transparency, user-friendliness, and reliability of the system were conducted by allowing a small group of students of various backgrounds to perform experiments mapping out surface phase diagrams on silicon surfaces. Preliminary results of this study show that an effective set of engineering controls can be designed. The conflicting problems between transparency and reliability addressed in designing this system are not specific to Molecular Beam Epitaxy, but to any educational institution whose mission is to create reliable training tools in all fields of engineering and technology.

VT-ThP5 Vacuum Chamber Design at National Synchrotron Light Source II, ***J.-P. Hu***, *H.-C. Hseuh, C. Foerster*, Brookhaven National Laboratory

National Synchrotron Light Source II (NSLS-II), proposed to be built at Brookhaven National Laboratory, will be a 3-GeV 800-meter circumference 3rd-generation synchrotron radiation facility. To provide a highly-stable and highly-focused synchrotron beam for advanced research, vacuum pressure at 10-9 Torr or below in the storage ring during normal operation is deemed critical. The approach for achieving such ultra-high vacuum would rely on the effective arrangement of non-evaporable getter strips, titanium sublimation pumps, and sputter ion pumps along the ring chamber, under proper in-situ baking and beam conditioning. The ring chamber will be made of aluminum through extrusion followed by machining, from which side-ports and ante-chamber can be precisely made to accommodate photon absorbers, lumped and distributed pumps. To test the design of the vacuum system, Monte Carlo-based Molflow and gas diffusion solver Vaccalc codes are utilized to calculate the pressure variation in channels hosting the electron beam, based on different pumping setup in models. Spare aluminum chambers of the Advanced Photon Source in Argonne Laboratory, featuring similar cross section as the NSLS-II proposed, will be used in bench test of pumping performance, thereby verifying pressure profile from code simulation. Updated design to improve ring vacuum and thus beam quality will be presented per project progress. (Work performed under auspices of the United States Department of Energy, under contract DE-AC02-98CH10886).

VT-ThP6 Viscosity and Diffusion Coefficient for a Gas Mixture Flow in a Tube, Valid Over the Whole Range of Knudsen Numbers, ***M. Vukovic***, Tokyo Electron U.S. Holdings Inc.

The viscosity and diffusion coefficients for a two-gas mixture, valid over the whole range of Knudsen numbers (Kn), are obtained by applying the generalization procedure of Beskok and Karniadakis (Microscale Thermophysical Engineering 3, 43, 1999) to the Boltzmann equation solutions of a gas mixture flow in a pipe by Sharipov and Kalempa (J. Vac. Sci. Technol. A 20(3), 814.,2002). The transport coefficients are expressed in terms their continuum limit value, multiplied by a correction factor that depends on Kn and the species masses and relative concentration. These coefficients are applied to the problem of gas counterflow in the Kn=1 range.

VT-ThP7 New Apparatus for Testing Hermetically Sealed Packages of Electronic Devices, ***M. Kinugawa***, *H. Kurokawa, S. Takagi,* Mitsubishi Electric Corp., Japan, *H. Kawata*, Wave Technology Inc., Japan

Hermetically sealed packages are widely applied to optical and high-frequency devices to maintain high reliability. The inert gasses, which are usually inserted in such packages, might contain such impurities as moisture that could damage the device. Therefore, it is crucial to know the variety and the amount of impurities in the filled gas. In this study, we show a new technique for analyzing gas in sealed packages. The advantage of our new technique is that analysis precision does not depend on package size. The testing apparatus consists of a sample chamber and an analysis chamber; they are both connected to a vacuum-tight valve and an exchangeable orifice. The analysis chamber has a quadrupole mass spectrometer and is exhausted continuously by a turbomolecular pump. The sample chamber has a rotating vacuum feedthrough that can mount several types of sample stages, a perforator, a viewport, and another pumping system. After setting sample packages on the sample stage, the sample chamber is pumped down by the pumping system. Then the pump is switched off, and the valve between the two chambers is opened, so the sample chamber will only be exhausted from the analysis chamber through the orifice. A pinhole is made on the sample package by the perforator. The gas in the sample package comes out and flows through the orifice from the sample chamber to the analysis chamber, and then the mass spectrometer in the analysis chamber detects the gas. We can get the gas composition from the integral ion intensity measured by the mass spectrometer and its ion sensitivity. The conductance of the orifice is determined by considering the sample size and the maximum vacuum pressure in the analysis chamber to keep the pressure a little lower than the working upper limit of the mass spectrometer. This technique allows accurate measurements of gas composition regardless of size package. We have already applied this technique to the development of new devices with higher reliability.

VT-ThP8 Optimization of a Multitarget Sputtering System for the Production of Magnetic Tunneling Junctions and Multilayers, *A. Chiolerio,* ***P. Martino***, Politecnico di Torino, Italy

Our work consists in a renovation project for an obsolete multitarget sputtering system, previously used for industrial purposes, in order to revert it to research objectives with a cost-effective operation, saving as many original components as possible. The system was equipped with a control rack, a large cylindrical vacuum chamber and a complete rotary / turbomolecular pump evacuation subsystem; substrates where inserted into a slit close to a vacuum oven by vertically lifting the whole chamber above the steel basement by means of an oleodynamic piston. The rotating oven slit was manually positioned above one of the three target sources allowing a rotation of 270°. Our newly realized system maintains the original control rack, the evacuation subsystem and the basement. A smaller cylindrical chamber has been designed in order to reduce both void spaces and evacuation time; all inner parts of the AISI 316L walls have been polished to minimize the outgassing rate while the opening is assisted by a vertical lift motor and performed only for scheduled maintenance, because a load-lock chamber is now connected to the operation chamber via a gate valve. This smaller buffer chamber has been designed either to insert and recover substrates or to serve as a second process chamber for the realization of tunneling barrier thin oxyde layers, where an oxygen line inlets the reactive gas and a sapphire window allows UV radiation to assist the critical step. Specimens are transferred to the carrying slit inside the process chamber via a magnetic manipulator; this slit is positioned above the desired sputtering source by means of an AC brushless motor operated by a remote control software. The rotating subsystem allows a full rotation (360°), the running cables being substituted by an ad hoc designed electrical rotating contact that ensures quite low electric field at contact point, no debris and appropriate friction during operation. A particular manual implementation allows one to choose between the simultaneous rotation of two coaxial axes and the movement of only one of them. The first axis is connected to the substrate slit and the other one to the shutter, which may interrupt the deposition process or interpose suitable masks to transfer geometries to the substrates. This solution ensures a higher vacuum level, with only one mechanical feedthrough, as well as much lower costs.

VT-ThP9 Influence of the Adsorption Gas on Friction Coefficient and Wear Track., ***A. Kasahara***, *M. Goto, Y. Pihosh, M. Tosa*, NIMS, Japan

Surface modification of sliding motion materials is inevitable to reduce friction as well as outgassing in a vacuum. We have therefore studied the development of advanced vacuum motion materials by control of surface roughness on a submicron scale. We have successfully found that any material sheet with about 100nm-250nm surface roughness showed same friction coefficient in a vacuum as at an atmospheric pressure for Type 304 austenitic stainless steel materials and anodic oxidation processed aluminum materials. Materials with except 100nm-250nm surface roughness shows a different friction coefficient for the friction measurement in a vacuum and at an atmospheric pressure. Type 304 austenitic stainless steel sheets had a larger friction coefficient in a vacuum than at an atmospheric pressure. The anodic oxidation processed aluminum sheets had a smaller friction coefficient in a vacuum than at an atmospheric pressure. We therefore studied the relation between friction coefficient and cross-section shape of wear track depth by an atomic force microscope (AFM) Type 304 austenitic stainless steel sheets had a deeper wear track in a vacuum than at an atmospheric pressure probably because the increase in friction coefficient to the desorption of the adsorption gas as a lubricant. The anodic oxidation processed aluminum sheets had shallow wear track in a vacuum than at an atmospheric pressure probably because the adsorption force generated by the applied load was reduced by the desorption of the adsorption gas. As a result, it was thought that the absorption layer on the materials surface influenced by the surface roughness had an important role on friction.

VT-ThP10 Atomic Layer Deposition Reactor with In Situ Diagnostics for Studying Gas-Surface Interactions, ***V. Rai***, *B.N. Jariwala, S. Agarwal*, Colorado School of Mines

In this presentation, the authors will describe the design and fabrication of a custom vacuum chamber for studying the heterogeneous surface chemistry during thin film deposition. The chamber is ideally suited for investigating the film growth mechanism during atomic layer deposition (ALD). The reactor consists of a cylindrical stainless-steel vessel, which is 10 inches in diameter, 6 inches in height. The reactor volume has been minimized to reduce the residence time of the gases to minimize the purge duration in an ALD cycle. The chamber is equipped with multiple ports for instrumentation, sample manipulation, and in situ surface and gas-phase diagnostics. The substrate is clamped to a heated plate, and the deposition temperature can be varied from 40 to 300 °C. The reactor is pumped by a 240 l/s turbomolecular pump, which provides a base pressure of 9×10^{-8} Torr. The chamber also has a parallel-plate, capacitively-coupled plasma source operating at a frequency of 13.56 MHz to generate radicals for plasma-assisted ALD. The distance between the plates can be varied from 4 cm to 9 cm using flexible linear motion bellows. The oxygen inlet into the reactor is equipped with an ozone generator to provide an alternate oxidant during metal oxide ALD. To deliver controlled amounts of low volatility precursors, we employ pressure-based mass flow controllers that require an inlet pressure of only 4 Torr and do not heat the temperature-sensitive precursors. The reactor is equipped with three in-situ diagnostic tools - (1) attenuated total reflection Fourier transform infrared (ATR-FTIR) spectroscopy, (2) quadrupole mass spectrometry (QMS), and (3) quartz crystal microbalance (QCM). In addition, a set of ports is available for in situ spectroscopic ellipsometry. The combination of ATR-FTIR spectroscopy and QCM provide sub-monolayer sensitivity to surface adsorbates. The QMS, which is placed in a differentially pumped housing, is used to detect the surface reaction products. Specifically, we will present results from gas-surface interaction studies during the ALD of titanium dioxide using metal precursors such as titanium tetrachloride and titanium isopropoxide, and oxidants such as water, ozone, and O radicals.

VT-ThP11 A Real Time Monitoring Method on the Decomposition Degree of MOCVD Precursor through an Ultrasonic Diagnosis Method, ***J.Y. Yun***, *S.W. Kang, D.J. Seong*, KRISS, S. Korea

This study proposes a method for monitoring the decomposition state of the metal-organic precursor which is used for the Metal Organic Chemical Vapor Deposition (MOCVD) system. As the precursor of MOCVD is highly likely to decompose due to the instability of its chemical structure during processing, critical problems are generated for thin film formation and its yield in this case. Although real time monitoring technology on the decomposition degree of these precursors is essential for the next generation semiconductor process, both commercialized technology and fundamental research have scarcely been accomplished. Therefore, this study endeavors for acknowledgement by the semiconductor industry with a proposal for a real time monitoring method on the decomposition degree of the precursor through an ultrasonic diagnosis method.

VT-ThP12 Development of a Static Expansion Vacuum Standard at the National Institute of Standards and Technology, ***J.H. Chow***, *P.J. Abbott*, National Institute of Standards and Technology

The NIST Pressure and Vacuum Group maintains sub-atmospheric pressure standards that range from 10^{-7} to 10^{+5} Pa. These consist of orifice flow standards from 10^{-7} to 10 Pa and Ultrasonic Interferometric Manometers from 10^{-1} to 10^{+5} Pa. A new Static Expansion Standard is in development with an operating range of 10^{-3} to 10^{+3} Pa. The standard is composed of two spherical stainless-steel vessels with a volume ratio of about 100:1. The two vessels are interconnected with a stepper motor driven valve. An initial pressure of gas in the small volume is measured to high accuracy using a resonant silicon gauge and then is expanded into the evacuated larger volume. This expansion results in a pressure reduction of about 100. Further

evacuation and expansion cycles are used to produce lower pressures. The system is temperature controlled to within 0.1C with a thermoelectrically cooled enclosure. This new standard provides many useful benefits: First, the Static Expansion Standard generates pressures that encompass both the orifice flow and manometry standards without relying on gas flowmeters; Second, the standard enables fast and simple calibration of spinning rotor (SRG's) and capacitance diaphragm gauges (CDG's). Currently these calibrations require a very skilled technician and are done at very high cost to customers; Third, the system allows for a convenient comparison of manometer and vacuum standards using CDG's and SRG's respectively. Work is ongoing to characterize the system, including determining the volume ratio and estimating the uncertainties.

VT-ThP13 Custom-Designed Very-High Vacuum Chamber for Growth of Large Area Silicon Nanowhiskers Arrays via an Ion-Enhanced Vapor-Liquid-Solid (VLS) Mechanism, ***M. Bettge,*** University of Illinois at Urbana-Champaign, *D. Abraham,* Argonne National Laboratory, *S. Burdin, S. MacLaren, I. Petrov, E. Sammann*, University of Illinois at Urbana-Champaign

A VHV chamber was custom-designed for experimental growth of silicon nanowhisker arrays via a novel ion-enhanced Vapor-Liquid-Solid (VLS) technique. Growth was to be carried out on a self-organized metal seed layer on a Si or SiO_2 surface. A reactive magnetron sputtering system was needed to supply atomic Si to the growth surface under concurrent high-energy ion irradiation. The successful implementation of this growth technique required sample temperature control to 450°C, a bias voltage up to 3kV, and a reactive plasma environment. Additional deposition capabilities and process controls for several inert and reactive gases were also required. The design goal was to develop an economical system using standard vacuum hardware that allowed handling of two-inch Si wafers. A wafer stage using a halogen reflector bulb for temperature control was designed to meet the requirements for whisker growth. Protection of the insulators and wafer handling proved to be especially challenging during the design of this stage. The chamber design also included capabilities for wafer storage and wafer transfer between two DC magnetron sputtering stations and a miniature evaporator custom-designed to fit a $2^3/_4$-flange. This presentation will describe the realization of the chamber design, which made possible the processing of nearly four hundred samples to date. Ultimately, this enabled the growth of aligned Si nanowhisker arrays at temperatures below 200 °C and at rates up to 200 nm/min. Growth can take place on any substrate on which a thin Si film can be deposited.

VT-ThP14 A Low Pressure Chemical Vapor Deposition (LPCVD) System Designed for Epitaxial Growth of 3C-SiC on Si, ***M.P. Orthner,*** *F. Solzbacher, L.W. Rieth, E. Jung*, University of Utah

Silicon carbide (SiC) can be used as electronic material at high temperatures (>500°C) and in aggressive/corrosive gas and fluid media. Depositing thin films of 3C-SiC on Si will permit use of existing Si processing technologies on the substrate while the 3C-SiC is processed as the active layer. Cubic silicon carbide (3C) is the only polytype that can be epitaxially grown on Si. This material combination makes SiC useful in pressure sensors, accelerometers, and for encapsulation. A key problem for 3C-SiC is the number of defects formed during growth due to a 20 % lattice mismatch. The deposition of 3C-SiC on Si by low pressure chemical vapor deposition (LPCVD) has been reported using a number of different precursors and a wide range of operating conditions. Growth temperatures range from 650°C to 1400°C and pressures range from atmospheric to mTorr. An LPCVD reactor with unique hot zone geometry has been developed to achieve the required growth conditions to study the growth of 3C-SiC on Si. The system is a cold wall design using a 304 stainless steel (SS) water cooled vacuum chamber. Pressure feedback is controlled using a butterfly valve and MKS capacitance manometer down to 50 mTorr and is currently limited by the Alcatel 813B dry pump. The resistive heater is a 7" diameter graphite spiral used to heat 2", 3", 4", and 6" Si substrates. The heater is mounted 1" above the graphite wafer chuck that is rotated by a stepper motor to increase uniformity. An Omega IR2P optical pyrometer and temperature controller are used in conjunction with the 180A phase angle fired SCR to measure and control the substrate temperature. Substrate temperatures in excess of 1400°C have been achieved. A custom designed horizontal flow showerhead manufactured from 316L SS is located on the side of the wafer chuck. The gases pass horizontally over the heated Si substrates to form thin films. Silane and propane precursors are used to grow the 3C-SiC using the conventional carbonization growth technique first introduced by S. Nishino. Initial deposition of very thin (< 100nm) 3C-SiC on Si (100) substrates have been grown in the described reactor. Deposition conditions maintained a process pressure of 250 mTorr with temperatures ranging from 1200°C to 1400°C. The chemical composition, crystal morphology and surface properties were investigated in relation to the growth temperature.

VT-ThP15 Method of Diagnosing Mechanical Endurance of Dry Vacuum Pumps to High Throughput Environment, ***J.Y. Lim,*** *W.S. Cheung,* Korea Research Institute of Standards and Science, *B.H. Moon,* Samsung Electronics Company, Korea, *Y.H. Shin*, Korea Research Institute of Standards and Science

Dry Vacuum Pumps are encountering rapid expansion of harsh and high throughput applications to semi-conductor/display industry. Besides their ability of making superior clean environment, they are normally exposed to clean to very harsh gas applications, thus often very easily contaminated with process byproducts in the forms of hard particles or coatings on the overall interior of the pumps. For this reason, even before installation in the process lines, detection of latent endurance for the pumps is a very important factor to diagnose primary mechanical, functional ability and internal controllable parameter settings during actual processes. With 40 to 300 slm of continuous dry air flow for one to three hours dependent on the pumping speeds, ten dry vacuum pumps carefully selected from six worldwide manufacturers were differently responded due to their internal structures, cooling systems, and breaker settings for body protection due to high temperature. Parameters such as inlet pressure, power consumption, and sound/vibration as well as parameters from SPM (single pump monitoring system) were carefully analyzed to diagnose the latent endurance of each pump. Characteristics mappings for all parameters were established for 1200 and 1800 m3/h dry vacuum pumps. In the case of total power consumption, 4 to 8 kW are manifested in range of atm. to 10-3 mbar. Dry pump body temperatures were very fluctuant in several pumps, thus minor or major modifications for their cooling systems may be necessary for those pumps. At the end of each test sequence, sudden vent test was performed to verify the pumping down characteristics as well as power consumption. Exposed to sudden avalanching mass flow, several pumps are diagnosed as relatively abnormal compared to their initial pumping down characteristics. Based on experimental results with integrated laboratory experimental system, we propose recommended characteristics design guidelines for dry vacuum pumps in the semi-conductor and display industry in the course of serial evaluation periods.

VT-ThP17 ISAC / SEBT Vacuum System at TRIUMF, *I. Sekachev*, ***D. Yosifov***, TRIUMF, Canada

SEBT is the "Super" Energy Beam Transport line connecting the medium-beta superconducting linear accelerator with the experimental hall in the ISAC-II building at TRIUMF. The SEBT vacuum system consists of five independent sub-sections comprised of nine 280 L/s (N) turbo-molecular, 5 dry mechanical pumps, 22 vacuum gauges, and 37 valves. A liquid nitrogen cooled trap and fast valve protect the Linac from pump oil migration and particular matter potentially originating from vacuum disruptions in the Experimental hall equipment. A control system with appropriate interlocks is used for system operation and protection in accordance to protocol.

VT-ThP18 In-situ Diagnosis using FT-IR Spectroscope System Installed at the Exhaust Line of the Chamber and the Characterization of Al Metal Films with a New Precursor, ***S.W. Kang,*** *J.Y. Yun, D.J. Seong, Y.H. Shin,* Korea Research Institute of Standards and Science, *I.D. Yang, J.Y. Shim, J.C. Oh*, Quleap, S. Korea

In-situ Fourier transform infrared (FT-IR) spectroscope system was installed at the exhaust line of the chamber to monitor the by-products generated by gas phase reaction and surface reaction. The by-products of Al metal precursor (a new one) were changed as a function of deposition temperature and pressure and so on (deposition condition). The intensity of spectra measured at the exhaust line was also varied as a measured condition. In in-situ FT-IR spectroscopy studies vibrational spectroscopy reveals the gain and loss of the by-products as a function of the deposition condition. The behavior of the functional group (such as N-C, C-C, C-H, etc.) was monitored and from that, the temperature dependence of the film properties (ex: the film composition) could be explained. The basic properties of a new Al precursor will be introduced.

VT-ThP19 Consideration for the Role of Surface Boundary Layer and the Mechanism of Hydrogen Desorption in Stainless Steel, ***K. Akaishi***, University of Toyama, Japan

Tritium loaded stainless steel specimens of 0.5 mm thickness plate were prepared. When the specimen was chemically etched by about 70 μm in thickness,the amount of tritium trapped within the top surface was measured by β-ray induced X-ray spectroscopy technique. When the chemically etched specimen was immersed in argon gas flow in atmosphere at ambient temperature, more than 99% of tritium released from the specimen was tritiated water, HTO, and the amount of released tritium was measured as a function of time by counting technique. In this paper to evaluate quantitatively the above experimental results, a model for hydrogen transport is proposed, and results of numerical simulation for the tritium release are shown. It is demonstrated that the numerical simulation well

predicts the amount of tritium released from the stainless steel specimen in the experiment. This work will be discussed as an issue of outgassing reduction in stainless steel materials.

Authors Index

Bold page numbers indicate the presenter