Tuesday Lunch, November 1, 2005

Exhibitor Workshop
Room Exhibit Hall C&D - Session EW-TuL

Vacuum Components and Measurement Optimization

Moderator: C. Bryson, Apparati, Inc.

12:00pm **EW-TuL1 Cold Cathode/Quartz Crystal Combination Gauge***, **E. Drubetsky**,* Televac*; B.R.F. Kendall,* Elvac Associates*; N. Matsumoto,* Tokyo Electronics Co., Ltd, Japan*; N. Ohsako,* VISTA Corporation*; H. Hojoh,* Vacuum Products Corp.

Different types of combination vacuum gauges have been introduced lately in the attempt to cover a wide range of measurements from atmosphere down to ultra high vacuum. In most cases they utilize one thermal conductivity type of gauge (usually Pirani) and one ionization gauge (hot or cold cathode). A combination gauge containing a quartz crystal and a cold cathode sensor is described.The miniature quartz oscillator in the shape of a tuning fork is located in a small isolated chamber of the cold cathode tube.This design allows expansion of the measurement range from 10@-9@ Torr to atmospheric pressure.Tests confirmed measurement error is within ±10% for pressure from 0.001 to 760 Torr. Repeatability data and durability against process gases are also discussed.

12:20pm **EW-TuL2 Seal Life Test of 300mm Hybrid Chamber in PVD Thermal Cycle Environment***, **J. Zhou**, M. Evans, J. Klein, J. Vargas, Y. Zhou, R. Schmieding, H. Gao, D. Paul, B. Stimson,* Applied Materials

Physical vapor deposition (PVD) is a key process in semiconductor wafer manufacturing. A new 300mm PVD chamber design consists of two pieces: an aluminum chamber body and a stainless steel bottom plate with a Viton O-ring seal. The reliability of the bottom seal is a concern, as elevated temperature exposure may cause the O-ring to fail by heat hardening, reducing equipment uptime. Thus, an accelerated test was designed to evaluate the O-ring lifetime before vacuum leakage. In commercial use, 300mm wafer diameter PVD chambers need to be heated for three hours at 80% lamp power about once a week. Tests were conducted with: 1) 100% lamp power during heating; 2) tight vacuum pass/fail criterion; 3) increased temperature in one of the test chambers than the default 96Â°C setting to look at worst case. Each thermal cycle consisted of three-hour heating and three-hour cooldown. After every 10 cycles the test chambers were cooled below 40Â°C to obtain the specified vacuum. Seal leakage was evaluated every 20 cycles using an in situ gas analyzer. Test chambers passed 520 thermal cycles without measurable vacuum degradation. Assuming 52 thermal cycles are equivalent to one year of seal life, the test chambers were demonstrated to have a "thermal equivalent" seal life of 10 years, which is much longer than the design goal of five years. The test results, together with post-test O-ring FTIR analysis, provide high confidence in O-ring reliability, and establish a methodology to evaluate PVD chamber seal life.

12:40pm **EW-TuL3 Robust System Identification and Optimized Tuning for Control of Evaporation Processes: Benchmark Study Results of Manufacturing Performance***, G. Reimann, B. Vattiat, **M. Gevelber**,* Cyber Materials, LLC*; J. Hildebrand, C. Hildebrand,* Maxtek, Inc.

Crystal monitors have been used for over 30 years to provide real-time control of evaporation sources in order to maintain a desired deposition rate. However, the performance of these systems is dependent on proper choice of controller gains. Review of a number of commercial operations has revealed that many controllers are mistuned and fail to compensate for large deposition rate variation. In many cases, poor controller tuning actually magnifies rate variations. These significant variations adversely impact coating quality, reduce yield, and limit throughput. In an evaporation system, the controller must be tuned to react to the dynamic response characteristics and disturbances typical of evaporation processes. The tuner will need to robustly deal with the process nonlinearities and variations that occur during a run. While a number of tuning approaches have been developed or suggested for controlling evaporation processes, none are optimized for the specific conditions observed in the processes, nor are they designed to handle the variety of conditions that typically occur. We present our work on a robust and automatic method for obtaining optimized controller tuning. The performance of the proposed tuning is evaluated under manufacturing conditions. We propose a two step process that first robustly identifies the system characteristics, and then applies an appropriate optimization scheme that selects controller gains based on the identified process characteristics. By robust, we mean that the identification process works despite all variations observed in practice including arcing, nonlinearities due to operating point dependency, and variations in system characteristics. In addition to describing the new robust and optimized controller tuning scheme, this paper reports our initial benchmark performance results of the new controller tuning system, as well as our analysis of system drift in several manufacturing systems.

1:00pm **EW-TuL4 Internet-Enabled Vacuum Training System***, R. Groom, **S. Hansen**,* MKS Instruments, Inc.*; Y.J. Lee, M. Moslehi,* Semizone, Inc.

Realizing that an understanding of vacuum and related process monitoring and control instrumentation is a key area for individuals who are technical workers in the semiconductor industry, MKS developed an integrated set of instructional literature and hardware for the teaching of vacuum and instrumentation practice. At the center is a table-top vacuum training system (VTS) which replicates the features and functions of a full-scale process tool. In 2004 MKS Instruments partnered with Semizone, Inc. to implement an Internet-enabled version of this vacuum training system. The system consists of most components found in a typical vacuum process tool including plasma chamber, high vacuum valve, throttling valve, mass flow controller, capacitance manometer, Pirani gauge, hot cathode ion gauge, RGA, and other components. Because the system was re-designed and built as an Internet enabled tool, all components (including components that are typically manually controlled) can be remotely actuated. The various sensors and actuators on the VTS interface with the equipment controller/server through adapters that convert legacy protocols into TCP/IP protocol. The equipment controller/server obtains the sensor readings and provides the control commands to the VTS. The equipment controller/server also communicates with the end user through client software using SOAP/XML protocol over a secure intranet or Internet connection. The client software provides graphical user interface and data analysis/interpretation tools. The remote access to the VTS is integrated with other Internet-based content including lecture modules, live video feeds, discussion forum, and online simulators.

1:20pm **EW-TuL5 CompuVac NT - A New Generation Vacuum System Design Tool***, **P.J. Klingner**,* Leybold Vacuum GmbH, Germany

Vacuum system design which meet the customer's requirements best is the goal of any vacuum equipment manufacturer. To achieve this the reliable modeling of the adequate system of pumps and conductances is a necessary and decisive precondition. Being in use for nearly two decades, Leybold's purpose-built software tool CompuVac has been successfully revised and transferred to the Windows@super TM@ environment now. The program helps to predict essential parameters as the effective pumping speed, pump down behaviour and power consumption reliably. Problems specific to a given vacuum system can be detected and purposively solved.

Exhibitor Workshop
Room Exhibit Hall C&D - Session EW-WeL

XPS and SPM New Developments and Applications

Moderator: C. Bryson, Apparati, Inc.

12:00pm **EW-WeL1 Improvement of the Quantification from XPS Data Using Predetermined Spectrometer-Transmission Functions with UNIFIT 2004***, **R. Hesse**, P. Streubel, R. Szargan,* University of Leipzig, Germany

The reliability of the quantification from XPS data was improved using calibrated intensity scales of the photoelectron spectrometer ESCALAB 220 iXL. Two different sub-routines, survey-spectra approach (SSA) and minimizing the error of the quantified peak-area approach of standard peaks (QPA), for estimating the transmission functions T(E) of different acquisition modes of any photoelectron spectrometers are integrated in the software UNIFIT 2004. For the method SSA the spectra from Au, Ag and Cu measured on the Metrology Spectrometer II of NPL have been used. The estimation of T(E) using the method QPA was carried out by means of the peak areas from Au 4f, Au 4d, Au 4p@sub 3/2@, Ag 3d, Ag 3p@sub 3/2@, Cu 3p, Cu 2p@sub 3/2@, Ge 3d and Ge 2p@sub 3/2@ lines measured for Mg K@alpha@ and Al K@alpha@ X-rays. The theoretical basis of quantification as well as the results of the transmission functions T(E) (E - kinetic energy) of the spectrometer have been considered for both approaches SSA and QPA.. In the presented paper the influence of pass energies (10 eV and 50 eV), lens modes (Large Area, Large Area XL, Small Area 150) and X-ray sources (Al/Mg-twin and Al-mono) on T(E) is discussed. It was found that the form T(E) = a+bE@super c@ (a, b, c - parameters) gives an appropriate approach to describe T(E) of the studied spectrometer modes in many cases. In order to demonstrate the applicability of the calculated functions T(E), a quantitative analysis of the sample Ni90Cr10 was performed. Keyword: UNIFIT, Spectrum analysis software, Photoelectron spectroscopy, Quantification, Transmission function, Intensity/energy response function.

12:40pm **EW-WeL3 Latest Development in Environmental Scanning Probe Microscope - Membrane of a HELA Cancer Cell***, S. Xu, **C. Wall**,* Molecular Imaging Corp.

The presentation will focus on the following topics: a) the environmental AFM application in chemistry, material science and biomaterial research; b) Nanografting: fabrication of nanometer size patterns using AFM and the potential application in development of biosensors; c) Post-imaging data processing, data rendering and analytical techniques; d)nanometer level mechanical testing application in biological materials. Many experiments benefit from imaging under controlled conditions: for biological applications imaging at 37 C is often crucial and controlled gas environments (oxygen, carbon dioxide etc) is frequently required. Electrochemical measurements are carried out in solution, mostly at the absence of dissolved oxygen, polymer studies are affected by humidity and temperature. In-situ real time "nano-movies" can be taken at programmed changing temperature between -40 C to +250 C. Various experimental results will be discussed using versatile imaging modes and under wide range of environmental controlling techniques. The concept of AFM nanolithography includes a list of surface chemistry reactions that could be used to create nanometer level patterns using atomic force microscope. Fabrication of nanometer size patterns attracted tremendous attention because patterned surfaces can be used as the building block for a wide range of research in developing biological sensors, nanodevices and masks for fabrication of nanoelectronics. Through chemically active nanopatterning, surfaces can be engineered with nanoscale spatial resolution. The concept of NanoGrafting includes a wide range of SPM assisted nanolithography techniques which could yield nanometer size patterns with desired chemical functionality on a variety of substrates. AFM images not only give a topographic view of the sample surface with high resolution, post-imaging processing can also allow researchers to extract more quantitative information of the experiments. Skillful data rendering not only can help the enhancement of spatial resolution, using Texture Mapping, advanced imaging mode data can be displayed with much more informative format and striking clarity.

1:00pm **EW-WeL4 Dynamic Scaling during Shadowing Growth of Ru Nanorods***, **L. Li**, F. Tang, T. Karabacak, G.-C. Wang, T.-M. Lu,* Rensselaer Polytechnic Institute

We present a comprehensive study of dynamic scaling behavior of ruthenium nanorods grown by oblique angle sputter deposition with substrate rotation. The vertical nanorod arrays with various lengths (~ 40 to ~ 480 nm) were grown on silicon substrates tilted with an angle ~85° from the surface normal of the sputtering target. The images of the nanorods were obtained by atomic force microscopy (AFM) and scanning electron microscopy (SEM). The images were analyzed using morphological analysis methods including power spectral density and autocorrelation functions. We observed that the Ru nanorods generated a quasi-periodic structure defined by a wavelength (@lambda@) as a result of shadowing effect. Moreover, the wavelength @lambda@, rod number-density N, rod diameter W, root-mean-square roughness @omega@, and lateral correlation length @xi@ (which measures an average distance within which the surface heights are correlated and is different from the wavelength) all change with rod height h according to a power law relationship, ~h@super p@, with exponents p@sub &lambda@ = 0.43 ± 0.02, p@sub N@ = -1.01 ± 0.02, p@sub W@ = 0.47 ± 0.09, p@sub &omega@ = 1.11 ± 0.01, and p@sub &xi@ = 0.55 ± 0.02, respectively. The measured values of the exponents p@sub W@, p@sub &omega@, and p@sub &xi@ are consistent with the results of theoretical models on oblique angle growth that include the effects of shadowing effect and isotropic surface diffusion. However, the exponents p@sub &lambda@ and p@sub N@ are not predicted by any previously known growth models. @FootnoteText@ F.T. is the recipient of the Harry Meiners Fellowship.

1:20pm **EW-WeL5 A New Approach to SPM Control Electronics***, **M. Maier**, B. Uder,* Omicron NanoTechnology, Germany

We developed a control system that couples advances in digital electronics with the requirements of the latest SPM applications to offer an extremely high level of experimental flexibility and data processing control. Fundamental to its modular philosophy are a series of advanced digital boards each equipped with CPU, DSP and logic elements. Programmable elements are "soft-wired" opening up to new functionality such as multi-channel feedback, input/output trigger control, pre-emptive feedback, and non-orthogonal and non-linear scan generation.

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