

Wednesday Afternoon, October 27, 1999

Vacuum Technology Division Room 610 - Session VT-WeA

Dry Pumping Systems

Moderator: K.M. Welch, Consultant

2:00pm **VT-WeA1 Dry Vacuum Pumps - A Method for the Evaluation of the Degree of Dry,** *A.D. Chew, R.P. Davis, R.A. Abreu, BOC Edwards, U.K.*

INVITED

The drive towards dry vacuum pumping has occurred across the spectrum of vacuum applications from semiconductor manufacture to industrial processing. This brings with it a need to systematically evaluate and quantify the degree of cleanliness characteristic of any particular pump; currently there is no universally accepted method to perform this function. A methodology which has been developed for repeatable measurements of pump cleanliness will be discussed. It is based on residual gas analysis under carefully controlled pump conditions. This facilitates direct comparisons of cleanliness between pumps of the same and different design. Additionally it allows for the assessment of methods introduced to improve cleanliness.

2:40pm **VT-WeA3 Ebara AAS-series Screw-type Dry Vacuum Pump,** *Y. Watanabe, R. Ward, Ebara Technologies, Incorporated*

INVITED

A new screw-type dry mechanical vacuum pump from EBARA Corporation employs two-stage main pump screws and DC brushless motors to reduce energy consumption and the resulting greenhouse gas generation. The patented Zero Theoretical Clearance screw profile permits tighter mechanical fits and increases pumping efficiency.

3:20pm **VT-WeA5 Adapting Dry Vacuum Technology to Cu CVD Effluent Abatement in Integrated Circuit Manufacturing,** *J.R. Bottin, D.G. Mrotek, Leybold Vacuum Products*

INVITED

Developments in the manufacture of IC's are driven by the need for a higher transistor density and increased speed. The semiconductor industry is aggressively pursuing techniques that enable 0.18 μm interconnects, with the goal of 0.13 μm by 2003 or sooner. Because of its low resistivity and high electromigration resistance, copper is the metal of choice for sub-quarter micron interconnects. New development will be required for copper processes including the abatement of copper and copper by-products. Chemical vapor deposition (CVD) of copper utilizing a liquid precursor is an efficient means for depositing seed layers of copper for high aspect ratio geometry. The reaction of the liquid precursor produces Cu, Cu(hfac)₂ and TMVS, which all have unique properties that can lead to premature dry pump failure and high abatement costs. A viable, environmentally friendly solution has been developed and is comprised of an optimized dry pump, inlet reactor, cooled exhaust collector and resin bed abatement device with integrated electrical control. The inlet reactor decomposes the residual liquid precursor leaving the tool and removes elemental copper. The residual Cu(hfac)₂ and TMVS remain in the vapor phase through the vacuum pump. The mixture is then cooled in an exhaust collector where Cu(hfac)₂ is condensed prior to entering the resin bed abatement device, where the TMVS is subsequently removed. The exhaust collector has been designed as a shipping vessel to transport the collected Cu(hfac)₂ back to the manufacturer for recycle, significantly reducing abatement costs. The system goal for 99% or greater removal of each component at the exhaust of the resin bed is presently being validated through beta-site testing. With copper interconnects representing the future of IC's, it is imperative that suppliers meet the process challenge posed by the use of copper. The system described above is a critical step toward meeting the challenge of Cu CVD effluent abatement.

4:00pm **VT-WeA7 Dry Pumping,** *S. Doherty, F. Ramberg, P. Annandale, Alcatel Vacuum Products*

INVITED

There are many reasons to convert from oil sealed, or so called 'wet,' vacuum pumping systems to those where no seal fluid or lubricant is exposed to the process gas. Among these are contamination, cost, and environmental impact. With certain deposition processes this conversion presents problems related to the phase change of the material pumped and its effect upon the pump and its handling by subsequent abatement systems. Alcatel has studied and characterized several processes that presented extremely difficult challenges in the conversion from wet to dry pumping. These conversions were ultimately successful due to an understanding of material properties and reactions possible within the

pump and system hardware and the correct management of pump design and application. Alcatel will present process analysis, design features, and operating data that demonstrate how such classically difficult processes may be converted from wet pumping to dry pump systems. The analysis will include phase diagrams of the materials and products of reaction for the process, conductance calculations for the piping system, and the pumping speed requirements. A survey of dry-pump design types demonstrates why the process is difficult to achieve; and an in-depth discussion of the successful design is included. Finally, the data that demonstrate not only successful pump operation but, an accounting of process material is presented. What may be concluded from the presentation is what analysis techniques are available to determine whether a process will be difficult to convert from wet to dry pumping, and methods to predict what dry pump design type will yield success. Further, we will show the relative increase in reacted and reactive material exhausted from a dry pump over that from a wet system.

4:40pm **VT-WeA9 The Dry Pump in the Industrial Market,** *J. Scherbik, Stokes Vacuum Inc.*

INVITED

Dry pumps have been commonly used for some time in the semi-conductor market. This article discusses the pros and cons of a dry pump in the more traditional markets such as chemical, pharmaceutical, metallurgical, and vacuum coating. Different options will be presented along with a description of ancillary equipment. Cost of ownership is compared with more traditional types of vacuum pumps. Recommendations are included for pump sizing as well as discussing applications which might benefit from dry pumps.

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