AVS Meeting 2002 & Manufacturer Visits

Joe Herbert & Ron Reid
12th February 2003
Talk Outline

Joe Herbert
- Introduction to AVS
- Manufacturer Visits - Why?
- MKS Instruments, Boulder, Colorado, USA
- Granville-Phillips, Boulder, Colorado, USA
- Physical Electronics, Minneapolis, Minnesota, USA
- Ion Pumps - A Dilemma

Ron Reid:
- AVS Meeting Highlights
Introduction to AVS

- The American Vacuum Society organise an annual symposium in the AVS series, usually held in the autumn.
  - 2002 - 49th AVS, Denver, Colorado.
  - 2003 - 50th AVS, Baltimore, Maryland.

- ~17 Parallel Sessions including:
  - Applied Surface Science
  - Thin Films
  - Plasma Science and Technology
  - Vacuum Science and Technology (Biggest annual meeting)
  - Series of highly commended Short Courses (Strong Vacuum contribution)
Manufacturer Visits - Why?

- Significant part of groups activity is concerned with **VACUUM TECHNOLOGY**
  - Familiar with Capabilities/Products and Influence Future
- Equipment Manufacturers Focus on "Big Business"
  - Semiconductor Industry
- Continuous **Education Process** to Control and Influence Technology Developments.
  - Non Bakeable
  - On-Board Electronics (not suitable for radiation environments)
- Resulted in **Better Products**
MKS Instruments

- Best Known for **Capacitance Manometers** - Andover MA
- Offices and Service Centre in **Altrincham**
  - Main Products for DL - Total Pressure Gauge Systems
- MKS Spectra - **Crewe**
  - RGA Systems
- MKS Engineering - **Telford**

- 2002 Visit, HPS Division, **Boulder**, Colorado
  - **Total Pressure Measurement.**
INTERESTING FACT

- Colorado has an atmospheric pressure of 635 Torr compared to 760 Torr at Daresbury. (Typical Values)
Main Purpose of Visit

- Development of 937A Total Pressure Gauge Control Unit
  - Main TPG Controller used on SRS for last 7 years.
  - Draw Back - No. of Available Relay Interlocks (Gen. Issue)
    - Reviewed New Design (5-7,9)
    - Inspected β Unit. (Now Received)

- Development of Fully Bakeable Pirani Gauge
  - Reliability Issues - De-coupling Versions
    - Review Design Proposal
    - Agreed Future Strategy
    - β Gauge Now Received - awaiting tests.
Granville-Phillips

- Parent Company - Helix Technology UK Limited
  - Offices in Livingston
  - Production and Service - Longmont, Colorado.

- Small Presence in UK Market

- Best Known for Hot Cathode TPG’s
  - Flagship Product is Unique STABIL-ION® Gauge
    - High Precision Engineering
    - Stable performance over time
    - X-ray limit of $2 \times 10^{-11} \text{ Torr}$
Reason for Visit

- No DL representative has visited for >20 yrs
- Follow up of STABIL-ION® Gauge Reported Successes
- UK Presence Limited to Semiconductor Market - Establish a Link, assess capability.
- Early Information on New CONDUCTRON Gauge - Improvement on Pirani and Thermocouple Gauges
Physical Electronics

- Manufacture and Development - Minneapolis
- Local Service Centre and Sales - AGENT - Scanwel, Bala

- Main Interest:
  - Ion Pumps
  - Ion Pump Power Supplies
  - Titanium Sublimation Pumps and Power Supplies
Purpose of Visit

- Establish **Capability** for Diamond
- Review Latest Results for **New TiTan Ion Pump Elements**
- **Investigate** Testing Program
- Review Design of **New TSP Control Unit**
Outcome of Visit

- **Capability** for Diamond
  - New processing plant ordered
  - New premises in pipeline

- Latest Results for TiTan Pumps Indicate **Enhanced Performance** at UHV

- Testing Program Appears to be Fine

- New **TSP** Control Unit Demonstrated - **Meets Specification**
  - A Few Modifications Suggested
  - Test Unit Promised Early Part of 2003
Ion Pump Dilema

- Which Ion Pump Elements to Use?
  - Commercial Issues
    - Cost, Reliability, Delivery, etc..
      - Determined by Tender Process
  - Technical Issues
    - Best UHV Performance
    - Longevity (Performance Over Time)
      - Determined in Advance of Tender Process
Preferred Choice

- Noble Diode/Differential Diode (DI) Elements
  - Previous Tests
  - Experience
    - Overall Balance of Characteristics

- However Physical Electronics claim that TiTan pumps can challenge this wisdom by delivering at least an equivalent performance as DI pumps but for fewer £’s!
What's New about TiTan Ion Pumps?

- Novel use of Titanium and Tantalum metals in electrode structure of pump. (Both metals have been used in Ion Pumps for >15 years)

- Manufacturer claims Enhanced Pumping performance at UHV.

- Tailor Made Electrode Structure for Application
  - Ratio of Active Gases : Noble Gases
    - (CO₂, N₂ : Ar, He)
Basic Ion Pump Operation
Physical Electronics TiTan Ion Pump Range

**TiTan™ 30**
Cathodes with 30% tantalum to ensure vacuum stability against minor air leaks and low noble gas loads.

**TiTan™ 60**
Comparable to the TiTan DI, 60% tantalum provides stability for most applications using nobles gases in application processes.

**TiTan™ 100**
Ultimate pressure and application process time are critical to production. Complete tantalum pumping surfaces give maximum stability.

**TiTan™ CV**
The original ion pump element with two pure titanium cathodes for the highest pumping speed and stability for reactive gases.

**TiTan™ DI**
The classic approach to increased stability offering a full titanium and a full tantalum cathode plate.
Experimental vs Phi Published Data (Nitrogen)
Experimental vs Phi Published Data (Argon)
Conclusion

- **Testing Program Is Underway In The Vacuum Science Laboratory**

- **Results Due by End March 03**
Some selected highlights
NEG

Major highlight – presentation of Gaede-Langmuir Award to Chris Benvenuti (CERN)

- “Development of advanced gettering technology for particle accelerators”
  - Ti/Zr/V
  - Pump
  - Reduced secondary electron yield
  - Reduced photon desorption yield
  - Diffusion barrier?
NEG

W Knapp et al (Magdeburg)

- Interesting coating technique for encapsulating active getters such as Li, Cs.
- Uses a binary alloy with another metal which forms protective shell
- Lower activation temperatures
Accelerator Vacuum Systems

KEK-B (Y. Suetsugu)

- Design beam currents are 1.1 A and 2.6 A for 8.0 GeV electron and 3.5 GeV positron ring
- Copper chambers; baked to 150°C
- Desorption yield < 1.10⁻⁶ molecules photon⁻¹ at integrated linear photon flux of about 7.10²⁵ photons m⁻¹
Accelerator Vacuum Systems

![Graph showing relationship between beam dose and photon dose](image)
Accelerator Vacuum Systems

RHIC (H Hseuh)
- Gathering information on materials in high radiation environment
- Use of inconel to reduce eddy currents

NSLS (C Foerster)
- PSD data on copper with oxide removed
- Data to $5 \times 10^{24}$ photon m$^{-1}$
- Reduced yield compared to oxide coated

ESRF (R Kersevan)
- Report on long term use of NEG coated chambers
Outgassing

H Hseuh (RHIC)
- Reports that TiN coating does not reduce outgassing rate
- Some correlation between film thickness and outgassing

J Setina (Slovenia)
- Baking Stainless steel to 100C increases H\textsubscript{2} outgassing by a factor of 3.
- Baking to 250C reduces it by a factor of 50
Outgassing

Influence of Thermal and Surface Treatments on the Outgassing of Austenitic Stainless Steels Studied by Thermal and Electron Stimulated Desorption.

C. Benvenuti, P. Chiggiato, G. Chuste, J. Gavillet, I. Wevers, M. Taborelli

CERN, European Organization for Nuclear Research
1211 Geneva 23, Switzerland
Outgassing

- **Electropolishing** generates an oxide layer richer in Cr. The effect on the $H_2$ desorption is different for the three kinds of steel tested. A new $H_2$ peak has been observed at 700°C for 316L.

- **Electropolishing** introduces about 1/50 of the initial quantity of H. The added H is released at about 800°C when the chromium oxide layer is removed.
Outgassing

Electropolishing: gas quantity extracted by TDS normalized of that of cleaned samples
**Outgassing**

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- Vacuum firing (950°Cx2h) does not affect the mechanical properties of 316LN. It has been confirmed to be a powerful way to decrease H content. Its efficiency can be improved by reducing the H2 pressure during the treatment.

- Trapping sites plays an important role both during vacuum firing and on the subsequent H2 outgassing at room temperature, which may be reduced even further.

- ESD yields are not significantly affected by electropolishing and vacuum firing.
4 GLS

Argonne (Noonan)
- “Significant technological challenges for vacuum”
- 5 mm ID tube, copper plated stainless steel 316L
  - 2 m long
  - Specific pumping speed of 1 l sec\(^{-1}\) cm\(^{-1}\)
  - < 10\(^{-11}\) mbar
  - Surface roughness < 125 nm rms
- Smooth profile
  - Telescopic bellows
- Advanced layer deposition techniques for stainless steel, Al, Cu
  - Rapid prototyping of complex shapes.
Photocathode Gun (Hernandez)

- GaAs wafer in stainless steel ball support
- Support hand polished to 1 micron
- Sputter coated with SiO$_2$ and nitrogen implanted in a plasma source
- Small craters and microflakes field emit