SUMMER 2005

Your News Source For Semiconductor, Environmental, Chemical and Lubricants

# PerkinElmer News

PerkinElmer®
precisely.

## Semiconductor



## Environmental



## Chemical



## Lubricants



## Special Interest



### DRC Technology Crucial for Performing VPD Analysis at Balazs™ Analytical Services

The removal and control of metallic contaminants on the surface of silicon wafers, is an extremely important aspect of the semiconductor manufacturing process. During this high-temperature process, metals can diffuse rapidly into the silicon substrate and cause undesirable changes in the wafer's electrical characteristics, affecting both the performance and yield of the manufactured devices. In fact, as little as 108 atoms/cm2 of metallic contaminants on the surface of a silicon wafer can adversely affect manufacturing yields and increase device failure rates.

The most common approach used to measure these contamination levels is called Vapor Phase Decomposition, better known as the VPD technique.

> *Continued on page 2*

### ELAN DRC Taking Applied Speciation and Consulting, LLC into the Next Generation

ICP-MS has gained popularity over the past twenty years, based mainly on its ability to rapidly quantitate at the ultratrace metal contamination level. However, in its basic design, ICP-MS cannot reveal anything about the metal's oxidation state, alkylated form or how it is bound to a bio-molecule. The desire to understand in what form or species an element exists, has led researchers to investigate the combination of chromatographic separation devices with ICP-MS.

> *Continued on page 3*

### PerkinElmer and Arnel, Inc.-The Perfect Combination for the Best GC Separation

About the time that Microsoft® released MS DOS 5.0™ (1991), PerkinElmer and Arnel signed a cooperative engineering/marketing agreement to provide high-quality, reliable, turnkey solutions to the analytical community. This agreement brought together the company with the greatest experience in providing commercial GC systems – PerkinElmer – with the company that is globally recognized as the application-specific valved-GC company – Arnel. This agreement encompassed a plan to jointly engineer and market complete systems and guaranteed solutions that met industry standards and requirements.

> *Continued on page 11*

### A Better Way to Analyze Fuel Diluents in Lubricating Oils

From a fairly early age, most of us learn that there are certain things that are best not done. As a kid, I soon caught on that trying to retrieve my dropped candy from the neighbor's boxer dog nearly resulted in my nick name being changed to Lefty. As I got older, I also was fairly quick to learn that asking my wife if she got a sizeable discount on her new hair style could cause me more pain than could my neighbor's boxer. It could be said that analyzing fuel diluents in lubricating oils by flash-point analysis could fit into the same category as the items listed above. In the hope that time teaches how to do things better, we would like to discuss a new method for analyzing fuel diluents in lubricating oils using gas chromatography (GC).

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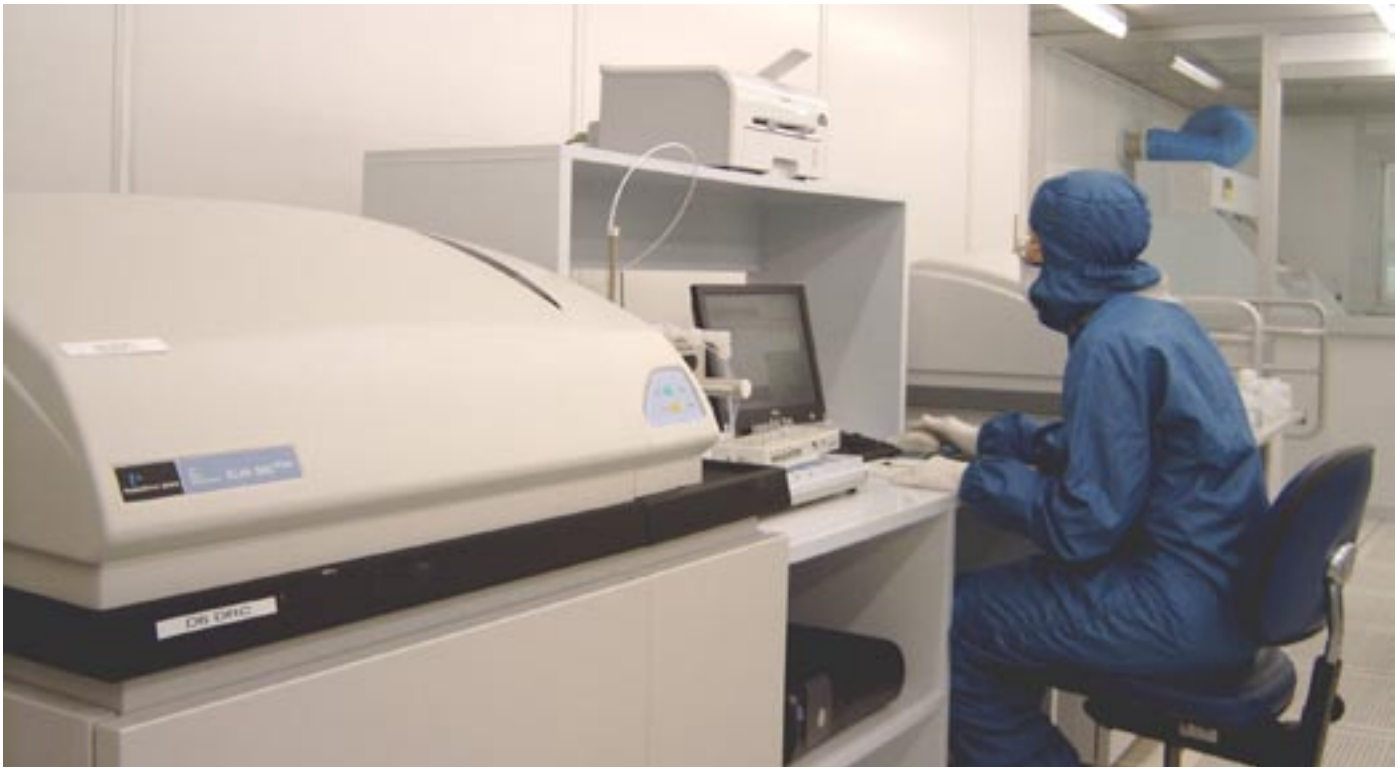
## DRC Technology Crucial for Performing VPD Analysis at Balazs™ Analytical Services



> *Continued from page 1*

With this approach, impurities on the surface of the wafer are concentrated into a liquid droplet by exposing a wafer to hydrogen fluoride (HF) vapor in a closed, chemically inert container. This results in the decomposition of the native or thermal oxide layer into droplets. These droplets are then rolled across the wafer's hydrophobic surface to ensure complete removal of the metallic contaminants. A small amount of dilute mineral acid and/or hydrogen peroxide is then used to gather all the droplets into one sample extract, with a final volume of about 500 µL. The sample is then carefully removed and analyzed by an instrumental technique such as ICP-MS for typically up to 40 metallic contaminants.1

Although ICP-MS is ideally-suited to carry out rapid, multielement analysis, the determination of 40 analytes at ultratrace levels in 500 µL of sample volume represents more of a challenge. The major problem lies in the fact that to determine the full suite of semiconductor-significant elements using conventional technology, both cool plasma and normal plasma conditions have to be used. This translates into a significant time penalty when changing over from one set of conditions to another. The result is a compromise in the number of analytes measured or a degradation in detection capability, if sample dilution is required. In addition, the high level of silicon present in VPD samples often prohibits the use of cool plasma conditions because the lower temperature plasma generates severe silicon-based matrix and spectral interferences.

However, even though this type of analysis is extremely demanding for a conventional ICP-MS system, the small sample volume does not pose the same problems for Dynamic Reaction Cell™ (DRC™) technology. Using the appropriate cell gas conditions together with the optimum selective bandpass tuning settings, DRC technology can determine all 40 analytes under one set of hot plasma conditions. This means a duplicate analysis can be carried out on 500 µL of sample using a suitable low-flow nebulizer. And, because hot plasma conditions are being used, the high silicon levels do not cause any significant matrix or spectral interferences.

One of the most respected semiconductor consulting and contract labs has also realized the benefits of DRC technology for this kind of work. Balazs™ Analytical Services, a part of the multi-national Air Liquide Industrial Chemicals and Gases conglomerate, has invested in three ELAN® DRC systems, mainly to carry out high-throughput VPD analysis at their lab in Fremont, CA. They typically measure between 10 and 30 elements including - Na, Mg, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Al, As, Sn, Pb, Cd, Zr, Li, Be, V, Ba, Ga, Ge, Sb - depending on

their customers' needs. Using the DRC, they can achieve detection limits in the order of 107 atoms/cm2, which translates into single-digit ppt levels in solution for a 300 mm wafer.

The person in charge of Balazs' inorganic method-development section with responsibility for running the VPD analysis is Senior Scientist, Dr. Fuhe Li. There is no question that his expertise has been one of the reasons that the Fremont Lab has gained such a high reputation in VPD analysis. But Dr. Li will also be the first to say that the ELAN DRC has played in integral part in gaining this kind of reputation and speaks very enthusiastically about its capabilities for this type of work. "The ELAN DRC has changed the way VPD analysis is carried out in our laboratory. Compared to traditional ICP-MS instrumentation that we previously used for the analysis, DRC technology has less spectral interferences, lower detection limits and higher productivity, because all the elements can be determined under one set of plasma conditions." This glowing endorsement is reflected in the fact that Air Liquide owns a total of nine DRC systems worldwide.

*Besides specializing in VPD analysis of silicon wafers, some of the other services offered by the ISO 17025-certified Balazs Analytical Services include the identification of ultra-low-level organic and inorganic contaminants in semiconductor-related samples such as ultra-pure water systems, processing and cleaning chemicals, etchants, inert gases, processing equipment, calibration of on-line measuring tools traceable to NIST standards, concentration of dopants and oxide thickness measurements of thick/thin films.*

In addition to utilizing three ELAN DRC's, they also use a standard ELAN 6000 coupled with a laser ablation system to get a better understanding of process-related FEOL (Front End of Line) and BEOL (Back End of Line) problems. This hybrid technique has proved invaluable as a problem-solving tool and is routinely used when the application necessitates the direct ablation of a solid material into the ICP mass spectrometer. Some of these applications include dopant measurements in ultra-shallow junction ion implantation and focused ion beam (FIB) deposition, surface and bulk analysis of silicon and dielectric thin films, microscopic analysis of solders and lead frames, depth profiling of interconnects and magnetic media, and micro contamination identifications of particles and defects.

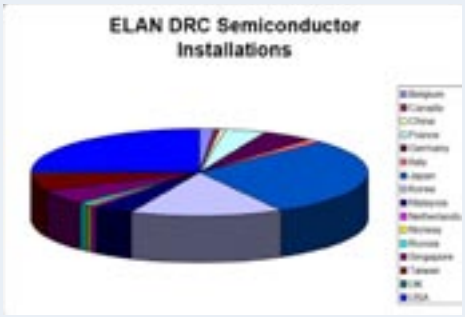
Besides their "center of excellence" in Fremont, they also have laboratories situated in Dallas, Texas, Fishkill, New York and Paris, France, where they run a total of almost 3000 samples every month. Balazs are extremely proud of the fact that with every sample analysis, it brings over 30 years of contamination expertise to help engineers find solutions and help control their manufacturing processes. Many companies in the electronics industry that take advantage of this expertise include integrated-device manufacturers, disk-drive producers and chemical and material suppliers. This philosophy can be summed up by Scott Anderson, the Director of Research and Development for Balazs Analytical Services, "We are very proud of the fact that the electronics industry uses our expertise because of our focus on customer service, dedication to accuracy and helpfulness in finding solutions to their contamination problems. ICP-MS together with dynamic reaction cell plays a very important role in achieving this."

There is not much more we can add to this statement, only to say that if you'd like to learn more about the applications discussed in this article, please refer to the following publications:

1. J. Fucsko, S. S. Tan, M. K. Balaz, Measurement of Trace Metallic Contaminants on Silicon Wafer Surfaces in Native and Dielectric Silicon Oxides by Vapor Phase Decomposition Flow Injection Inductively Coupled Plasma-Mass Spectrometry, Journal of Electrochemical Society, 140 (4) 1105, 1993.

2. F. Li and S. Anderson, Using Direct Solid Sampling ICP Mass Spectrometry to Complement SEM-EDX and SIMS in Characterizing Semiconductor Materials, Characterization and Metrology for ULSI Technology, Seiler D.G. et al. (Ed.), American Institute of Physics pp 715-719, (New York, 2003).

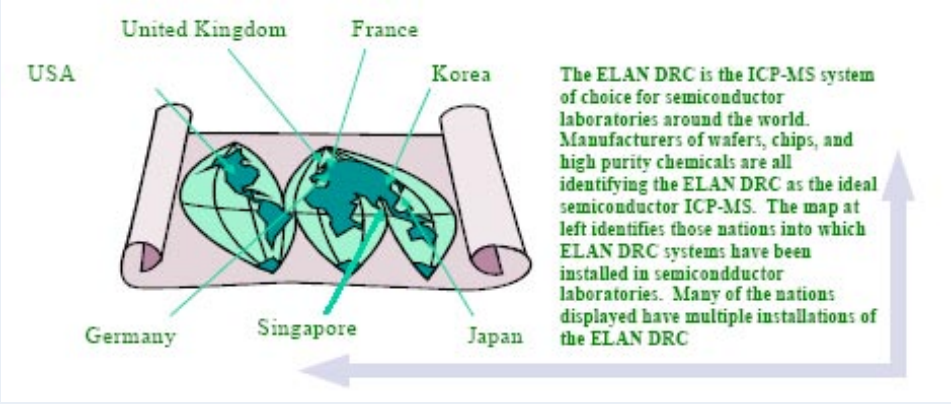
## ELAN DRC Installations in Semiconductor Laboratories




Sometimes it is good to take a look back to see how much progress we are actually making in an undertaking. It's a bit like mountain climbing when you reach a look out point that lets you see down to the base of the mountain where you started your trek. Then you realize that the hard work that you've just completed was all worth it.

As I began working on this newsletter, I thought back on the first newsletter that we prepared in October of 2000. The ELAN® DRC™ was a new instrument at that time and it was just gaining acceptance as a powerful tool for semiconductor analysis. At that time, we had placed several instruments into semiconductor laboratories in seven countries.

As work progressed on the newsletter, I became a bit like that mountain climber who wanted to gain a look out so that they could see the progress that they had made climbing the mountain. I pulled up our most recent user list and began a short analysis of the countries into which we have installed ELAN DRC systems for the analysis of semiconductor samples. The work was rewarding. In the four and one half years since October 2000, we have increased the number of ELAN DRC installations into semiconductor laboratories by 1500%. The countries into which those installations have occurred have more than doubled from 7 to 16. If you work in a semiconductor laboratory that has one or more ELAN DRC systems, we thank you for helping to make the ELAN DRC the new standard for ICP-MS in the semiconductor laboratory.




## Handing Off of the Baton

If you use our ELAN® DRC™ II for semiconductor applications, you almost certainly have worked with either Yoko Kishi or Katsu Kawabata, who have been our in-house ICP-MS experts for nearly five years. After many years of working for large corporations including Air Liquide, Yokogawa and PerkinElmer, Katsu and Yoko have decided it is time to follow their dream and start their own business. They have moved back to their home in Japan and have started a new company called IAS Inc. Their new company will focus on front-end accessories for ICP-OES and ICP-MS instrumentation and technical consultation for ICP-MS. Katsu and Yoko have agreed to work as consultants for PerkinElmer, where they will provide after-sale support to our ELAN DRC ICP-MS users. More about their company can be learned by visiting their website at http://IASinc.jp. The website can be displayed in either Japanese or English languages. We wish Yoko and Katsu every success in their endeavor.

With a continued commitment to the semiconductor industry, PerkinElmer has moved quickly to find an exceptionally strong individual to fill the large vacancy left by Katsu and Yoko. Fortunately, that person was found and she has been put into the position of Business Development Manager for the semiconductor industry which is based in our Singapore office. Her name is Chia Mui-Ping who comes to PerkinElmer from Merck Electronic Chemical Division (now BASF) in Singapore. With fourteen years of experience in semiconductor laboratories, Mui Ping brings to PerkinElmer a broad base of expertise developed through both education and career activities. As the manager of the analytical laboratory in Merck's Electronic Chemical Division in Singapore, Mui Ping developed a strong understanding of many analytical techniques including FTIR, GC/MS, and thermal analysis as well as reaction cell ICP-MS. At Merck, her responsibilities frequently took her outside of the laboratory where she interacted with customers in both pre-sale and post-sale interactions. Prior to working at Merck, Mui-Ping carried the positions of technologist and engineer at Seagate. Her educational credentials include a Bachelor of Science (Chemistry) from the National University of Singapore and a Specialist Diploma in Semiconductor Technology from Singapore's Temasek Polytechnic.

*Please join me in welcoming Mui-Ping to her new position at PerkinElmer. Mui-Ping can be reached by calling our Singapore office +65 67799558 - or by e-mail at Mui-Ping.Chia@perkinelmer.com.*

## ELAN DRC Taking Applied Speciation and Consulting, LLC into the Next Generation

The ICP mass spectrometer becomes a very sensitive detector for trace-element speciation studies when coupled to a chromatography system like HPLC (high performance liquid chromatography), IC (ion chromatography), GC (gas chromatography) or CE (capillary electrophoresis). In these hybrid techniques, different species of an analyte are separated on a column, based on their chromatographic retention/mobility times, and then eluted into the ICP mass spectrometer for detection. The intensities of the eluted peaks are then displayed in the time domain for each isotopic mass of interest. The major benefit of ICP-MS is that the extremely low detection capability has allowed researchers in the environmental, biomedical, geochemical and nutritional fields to gain a much better insight into the impact of different elemental species on us and our environment.

However, even though ICP-MS offers significant benefits over other detection techniques for speciation analysis, it is well-recognized that polyatomic spectral interferences derived from argon, matrix and solvent ions can degrade the detection limits of environmentally-significant elements like arsenic, chromium and selenium. There are ways of minimizing these interferences like matrix separation, sample dilution and/or cool plasma technology, but because they impact the overall speed of analysis, many ICP-MS users have traditionally preferred to use other techniques like electrothermal atomization (ETA) or hydride generation (HG) to ensure their sample productivity is not degraded. Unfortunately, these are typically single-element techniques, which necessitated the need for multiple runs (depending on the number of species being determined), resulting in lower lab productivity and an increase in the total cost of analysis. In addition, application of reaction chemistry to produce a quantifiable sample stream inherently involves operationally defined recoveries which can pose significant biases when dealing with complex matrices.

To get around these kinds of problems, an increasing number of labs are investing in the ELAN® DRC system to carry out speciation analysis, because of its ability to reduce the impact of spectral interferences on the analytes of interest without sacrificing sample throughput. Unlike simple collision cells which use kinetic energy discrimination to separate analyte species from interferences, DRC technology utilizes selective bandpass tuning. This unique feature allows the use of highly reactive gases like methane, ammonia and oxygen, which have proven to be essential in the determination of many of the environmentally-significant elements like arsenic, chromium, selenium and their different species in various matrices.

One such lab that has realized the benefits of the ELAN DRC system for elemental speciation analysis is Applied Speciation and Consulting, LLC (ASC) based in Seattle, Washington. Started by two scientists, Dr. Hakan Gürleyük and Russell Gerads, who have over 18 years combined experience in trace-metal analysis, ASC is an analytical testing and consulting laboratory which provides ultra trace metal and speciation analysis for the environmental, pharmaceutical, agricultural and research communities. When the two partners set up their new company recently, an ELAN DRC ICP-MS became one of the very first capital investments, due to historical positive experiences with the technology.

When questioned about the function of ASC in the scientific community, Mr. Gerads succinctly stated “ASC combines sound business practices with leading-edge science to provide economically viable solutions when absolute analytical certainty is needed. Services provided by ASC support all aspects of a project, from the initial investigation of a problem to the application of trace-metals analysis to identify the existence and scope of the contamination. Once the problem is identified, appropriate analytical tools such as speciation, sequential extraction and organic/inorganic trace-metals analysis are used to clarify risk assessment and mobility issues, to better understand if remediation is necessary.”

It is clear that information generated from speciation and other investigative work helps in the optimization of bench-scale studies prior to implementation and can also help to identify potential problems associated with the efficiency of remediation pilot plants. Traditionally, there are very few laboratories in North America that specialize almost exclusively in metalloid speciation analyses and, as a result, there has been haphazard method application and a lack of focus by the scientific community. By concentrating their experience, education and efforts on metals speciation and consulting, ASC is very proud of the fact that it can provide expertise not previously offered by any other commercial laboratory.

The logo for ASC, which is an artistic interpretation of the Pourbaix diagram for selenium, represents Dr. Gürleyük and Mr. Gerads’ passion for speciation and scientific understanding. Mr. Gerads imputed “We wanted the community to identify that true scientific development is an artform in itself. To look beyond the application of archaic methods for real-world sample analyses requires insight, experience and imagination.”

There is no question that the ELAN DRC system is going to play an important part in their mission, as summed-up by Dr. Gürleyük - “Our company is dedicated to utilizing state-of-the-art methods to provide the lowest detection limits and the most accurate data for the toughest matrices. The DRC technology plays an integral role in our commitment to client satisfaction.”

This kind of endorsement is music to our ears - to see a commercial environmental laboratory utilizing the capabilities of the ELAN DRC ICP-MS to provide research-based methods with high-caliber quality assurance. We always knew by the large number of happy users in the semiconductor and clinical application areas, that DRC technology offered unique advantages over traditional ICP-MS instrumentation. However, when this kind of analytical power is combined with a high-sample workload, it proves that DRC technology is not only capable of outstanding performance, but can also be considered a routine analytical tool for the environmental and geochemical communities.

We would like to leave the final word to Dr. Gürleyük - "My experience with the ELAN DRC system is that it is incredibly reliable with very little downtime and consistently generates data of the highest quality without having to carry out re-runs. The same cannot be said of another cell-based instrument I used, which consistently broke down and didn't meet strict performance requirements."

This is very much a compliment from a company with such a high level of trace-metal and speciation expertise. We very much hope the rest of the environmental monitoring and geochemical analytical communities will soon realize the benefits of DRC technology and follow in the footsteps of Applied Speciation and Consulting LLC, who are clearly "taking elemental speciation analysis into the next generation".

## Chromera Sets the Standard in Speciation Software

The 21st century is providing some exciting new challenges for the analytical chemist that span traditional boundaries and conventional thinking on how analytical chemistry measurements are performed. In many cases, it is no longer a question of answering "how much" is in the sample but "what forms" of the species are present; for example, not how much arsenic, but how much dimethylarsinic acid is present. The correct answer is crucial as many inorganic forms are extremely toxic, while most other forms are not. The answer affects environmental impact assessments and guides remedial activities.

*Speciation analysis is accomplished with the PerkinElmer Series 200 HPLC system performing the separation and the PerkinElmer SCIEX ELAN providing detection.*

Toxicity, bioavailability, metabolism and environmental mobility of elements are dependent on their form or species. Total element determination alone does not provide all the information. For example:

- Inorganic arsenic species are toxic.
  Organic species such as arsenobetaine are non-toxic.
- Chromium(VI) is more toxic while chromium(III) is an essential nutrient.
- Selenium species originate from different sources.

Environmental remediation depends on the species present.

Being a leader in separation technologies as well as the premier supplier of element-specific detection systems, PerkinElmer once again has recognized the needs of the analytical community. Need and productivity-driven systems have been developed that seamlessly couple HPLC elemental separation and ultra-high sensitivity detection with the PerkinElmer SCIEX™ ELAN® ICP-MS instruments into a fully integrated package called Chromera™ software.

Chromera software was designed by chemists for use in elemental speciation analysis. It presents a unified user interface that integrates and manages the ELAN ICP-MS and the Series 200 HPLC system. The tedium of having to switch between the ICP-MS and the HPLC to start the system or set up operating parameters is completely avoided. Chromera software sets a new standard for efficiency and optimized workflow.

## WEEE/RoHS

This is a set of initials you may have seen more frequently lately. But what do they mean, both in words and to our businesses?

Waste Electrical and Electronic Equipment (WEEE) directive

- In effect in the EU since August 2004
- Requires manufacturers to take back and recycle electrical products

Restriction of Hazardous Substances (RoHS) legislation

- Applies to the entire EU from July 2006
- Bans products containing > 0.1% Cr VI, Hg, Pb and > 0.01% Cd in homogeneous materials and two brominated flame retardants

Although these regulations were passed in Europe and are specifically enforced in the European Union, they will affect us all. You may see a new icon on certain electronic products that can be recycled through this rule in Europe. Manufacturers are always looking for ways to operate more efficiently and producing a different product version for delivery to Europe is not efficient. So, if development work is undertaken to comply with RoHS regulations, the same product will likely be sold in all areas in which the company operates. It is also likely that other areas of the world may adopt similar regulations. At this point, China and Japan are evaluating some aspects of the regulation for possible implementation in their countries.

PerkinElmer offers a number of instruments that can help manufacturing companies comply with RoHS regulations. Analysis of single or composite parts can be prepared and measured using a variety of techniques suitable for different cost and throughput requirements. The table below summarizes some of the choices by analyte.

For more information and to download a PDF of our brochure, please go to www.perkinelmer.com/environmental or contact your local PerkinElmer office (www.perkinelmer.com/lasoffices) to request our brochure (007020_02).

Analytical Equipment Used for Measurement of Banned and Restricted Substances

| Substance | Sample Preparation Digestion/Extraction Method | Analytical Method | Analytical Equipment |
|---|---|---|---|
| Cadmium (Cd)/Cadmium Compounds | EN-1122, U.S. EPA 3050B, 3052, EN-71-part 3 | U.S. EPA 7000, 6010, 6020 | Flame AA, ICP-OES, ICP-MS |
| Lead (Pb)/Lead Compounds | EN-1122, U.S. EPA 3050B, 3052, EN-71-part 3 | U.S. EPA 7000, 6010, 6020 | Flame AA, ICP-OES, ICP-MS |
| Mercury (Hg)/Mercury Compounds | EN-1122, U.S. EPA 3050B, 3052, EN-71-part 3 | U.S. EPA 7471, 6010, 6020 | Flame AA, ICP-OES, ICP-MS, or FIMS |
| Hexavalent Chromium (CrVI) | Extraction and Colorimetry | U.S. EPA 3060A/7196A, DIN 53314 | UV/VIS Spectrophotometry, HPLC/ICP-MS |
| PBB, PBDE | Extraction by U.S. EPA 3540C, 3541, 3550B, 3546, with sample clean up by U.S. EPA 3620B or 3630C | U.S. EPA 8270, 1614 | GC/MS |
| Short Chain Chlorinated Paraffin ($C_xH_{2x+2-y}Cl_y$) Cl Content ≥ 50 wt% | Extraction by U.S. EPA 3540C, 3541, 3550B, 3546, with sample clean up by U.S. EPA 3620B or 3630C | U.S. EPA 8270 | GC/MS |
| PCB | Extraction by U.S. EPA 3540C, 3541, 3550B, 3546, with sample clean up by U.S. EPA 3620B or 3630C | U.S. EPA 8270, 8082 | GC/MS GC/ECD |
| Polychlorinated Naphthalene | Extraction by U.S. EPA 3540C, 3541, 3550B, 3546, with sample clean up by U.S. EPA 3620B or 3630C | U.S. EPA 8270, 8082 | GC/MS GC/ECD |
| Organotin | DIN 38407-13 | DIN 38407-13 | GC/MS HPLC/ICP-MS |
| Azo Dyes | LMBG 82.02 | LMBG 82.02 | GC/MS |
| Ozone Depleting Substances (Hydroflorocarbon, HFCs) or Compounds with a Global Warming Potential above 15 | U.S. EPA 5021A | U.S. EPA 8260 | Headspace/GC/MS |
| Asbestos | None | | FTIR, FTIR/Microscope |
| PVC | None | | FTIR |

## PerkinElmer GC Systems Used to Monitor Air Quality

### Introduction

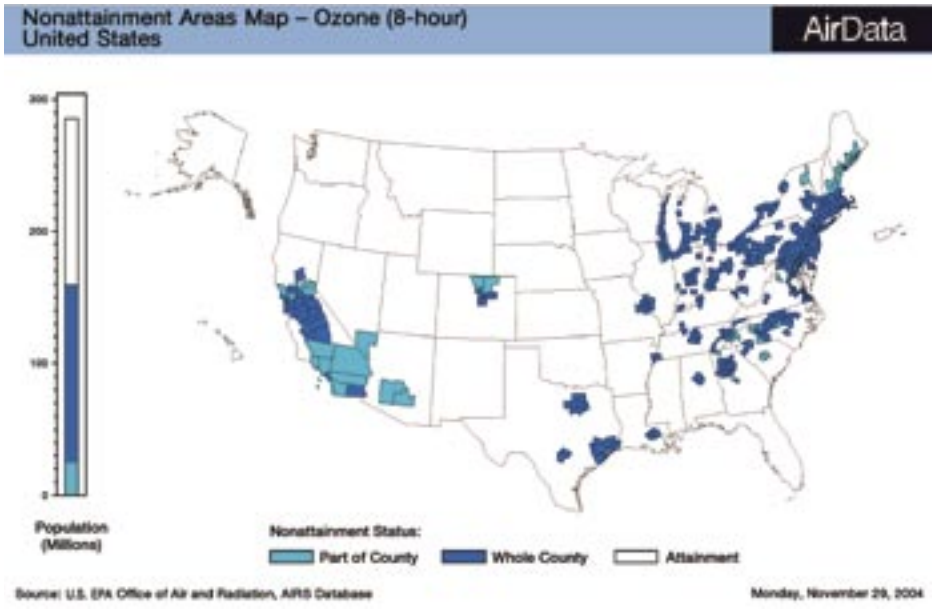
In the United States, the Clean Air Act of 1970 gave the Environmental Protection Agency (EPA) responsibility for maintaining clean air for health and welfare.

Six parameters are measured routinely in ambient air: SOx, NOx, PM10 (particulate matter less than 10 microns), Pb, CO and ozone. In the 1990 Clean Air Act Amendments, Title 1 expanded the measurements in air to include volatile organic compounds (VOCs) that contribute to the formation of ground-level ozone. These parameters are measured in urban areas that do not meet the attainment goals for ozone, as shown in the figure below.

These measurements are implemented through a program known as Photochemical Assessment Monitoring Stations (PAMS). Similar recommendations have also been made in Europe following the 1992 Ozone Directive and United Nations Economic Commission for European protocol on controlling VOC emissions. Although this program has been in place in the U.S. for a number of years, a recent EPA press release indicates that ozone concentration was reduced only 4% over the last ten years and remains a major health concern.

The analysis of C2 to C11 volatile organic ozone-precursor compounds can present a serious technical challenge to the analytical chemist. Low concentrations in the atmosphere, coupled with the need to monitor frequently to assess diurnal variations, means that a preconcentration step on the sample before analysis by gas chromatography

(GC) is required. While the samples can be collected in the field and returned to the laboratory, on-line analysis in the field allows reduced data turnaround time, minimizes sample collection hardware and permits the presence or absence of VOCs to be correlated with meteorological data.




*Areas not reaching ozone attainment goals (www.epa.gov).*

The heavily industrialized Baton Rouge, Louisiana area is taking the measurement of ozone precursors very seriously with a requirement that each refinery in the area provide monitoring at the fence line for ozone precursors. Although this monitoring can be performed by periodic sampling using Summa canisters, constant monitoring with a real-time system provides more immediate detection should the air quality rapidly change.

PerkinElmer's specifically engineered On-Line Ozone Precursor Monitoring System had proven its outstanding capabilities in other parts of the world, including the Houston, Texas area. By working closely with three of the major chemical companies in the Baton Rouge area, our people were able to show how our system can effectively monitor the ozone precursor levels in real time.

While more detailed information is available in our Application Note (007289_01) entitled "Ozone Precursor Analysis Using the TurboMatrix Thermal Desorption GC System", this article will just briefly describe the system that was provided to the chemical companies in the Baton Rouge area.

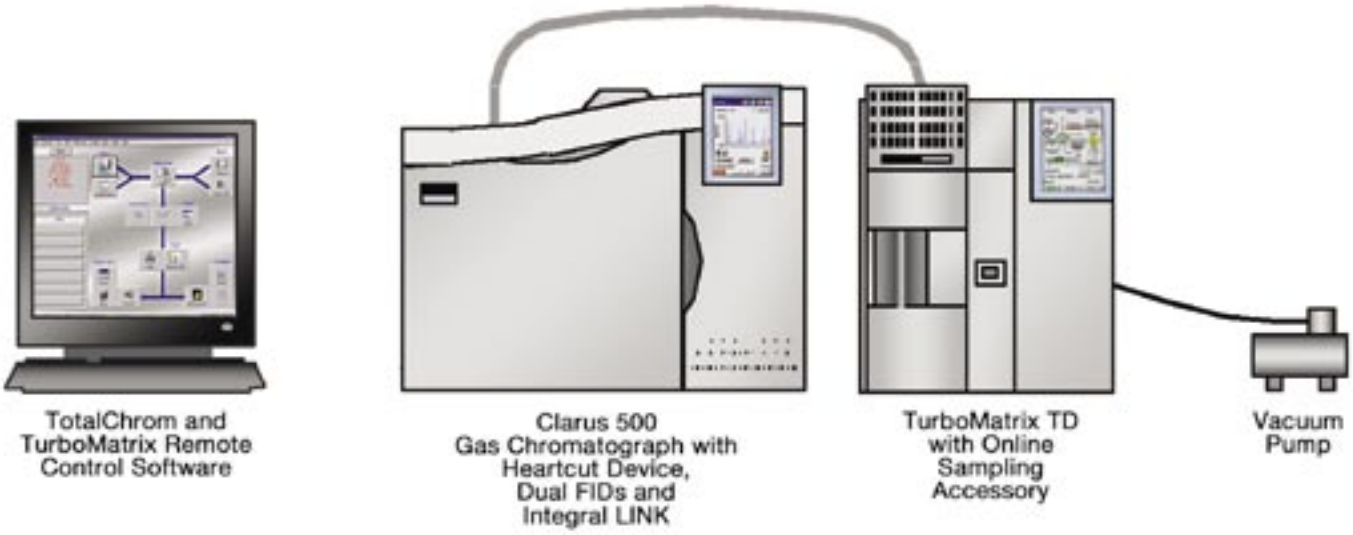
### System overview

Figure 2 gives a schematic diagram of the key components that comprise the PerkinElmer On-line Ozone Precursor Monitoring System. A TurboMatrix™ Thermal Desorber (TD) with installed On-line Sampling Accessory is responsible for collecting the sample – either directly from ambient air or from a sample previously stored in a passivated canister. The TD extracts the analytes from the sample onto a cooled adsorbent trap. The trapped analytes are thermally desorbed and carried through a heated transfer line by carrier gas into the Clarus® 500 Gas Chromatograph (GC). The GC contains two columns and a heartcut device to separate, by volatility, the analytes into two fractions. The more volatile fraction is separated on a PLOT (Porous Layer Open Tubular) column whereas the less volatile fraction is separated on a methyl silicone column. A flame ionization detector (FID) monitors the chromatography on each column. The PC runs the TotalChrom® data-handling system and the TurboMatrix Remote Control Software (RCS) to provide the automated control and

review of the settings and conditions that control the GC, the TD and the data processing. As an option, third-party remote control software may be used to provide access to the PC and the applications running on it from a remote location.

PerkinElmer has recently placed 13 On-Line Ozone Precursor Monitoring Systems into facilities in Baton Rouge, in addition to 30 systems that were previously placed in the Houston, Texas area. We are pleased that we have been able to make a contribution to the quality of the air in the Gulf Coast of the U.S. and we look forward to helping chemical companies around the world to do the same.

For more information concerning our On-Line Ozone Precursor Monitoring Systems, please visit our website at www.perkinelmer.com/environmental or contact your local PerkinElmer sales office (www.perkinelmer.com/lasoffices) and ask for our Application Note 007289_01 entitled "Ozone Precursor Analysis Using the TurboMatrix Thermal Desorption GC System".




*Key components of the PerkinElmer On-Line Ozone Precursor Monitoring System.*

## TurboMatrix Headspace Trap Analysis of Volatile Organic Compounds

PerkinElmer introduced a new concept to the market last year - headspace vapor concentrated on a trap before introduction into the GC, termed Headspace Trap. The system offers detection limits improved by a factor of 100 and better performance for compounds that do not purge well in a purge-and-trap system. The system has been widely accepted in many applications throughout the world. We are currently working with the U.S. Environmental Protection Agency (EPA) to demonstrate the analytical capability of the system for environmental applications to make it easier to adopt the technique for routine use in the U.S. We'll keep you posted on our progress!

## What do the following statements all have in common?

1. Referred to in the book of Genesis of the Bible as brimstone
2. Found in meteorites
3. Believed to be in the crater Aristarchus on the moon
4. Found in galena and cinnabar
5. Can be extracted from a well by the Frasch process
6. Insoluble in water
7. Contains seventeen isotopes, four of them occur naturally and none are radioactive
8. Found in fats, body fluids and skeletal minerals
9. Has properties of a metal when polymerized with a nitride
10. Can best be analyzed by a new product from PerkinElmer

As you have probably guessed by now, all these statements are talking about the element sulfur (also spelled sulphur).

Sulfur does play a very important role in the world including being essential to life itself. Sulfur is used in a wide variety of important materials including plastics, rubber, matches, gun powder, fertilizers, medication, cosmetics, antidandruff shampoos and in antidotes for acute radioactive exposure. On the other hand, sulfur can cause major problems in chemicals and petroleum products.

Sulfur detection systems have been available commercially for many years. Perhaps the most common technology used today involves chemiluminescence. In such a system, sulfur is combusted to SO, oxidized with O3 to SO2 and then a chemiluminescence reaction occurs. The resulting light is passed through an optical filter and measured by a photomultiplier tube (PMT). This technology is functional and it can be applied to a large spectrum of samples. By reputation, the technology requires a high degree of maintenance and is very operator-dependent. Many customers have approached PerkinElmer with the request that we provide a sulfur detector that is more rugged and easier to use than what is available today.

In response to those requests from our customers, PerkinElmer recently introduced the Amperometric Sulfur Detector (ASD). When the ASD is coupled with a PerkinElmer-Arnel GC, it is capable of providing highly accurate sulfur measurements for gas matrices over the dynamic range of 0.01 to 10.0 ppm. In the detector, sulfur compounds are reduced to H2S which are then swept into an electrochemical sensor. The signal from the sensor is amplified and measured. Extensive testing on the ASD has shown that its operation is straight-forward, produces an equimolar response, is exceedingly reliable and requires minimal maintenance.

We are pleased to offer several turn-key sulfur detection systems that are available from PerkinElmer-Arnel. Two Application Notes have been written which describe the capabilities of the ASD on real world samples. The first note describes the analysis of sulfur in bulk gases (specifically helium, hydrogen, nitrogen, oxygen, air, carbon dioxide and argon). The second note describes the analysis of sulfur in beverage grade CO2. Both Application Notes can be downloaded in PDF format from our web page at www.perkinelmer.com/ASD. They can also be ordered from your local PerkinElmer office (www.perkinelmer.com/lasoffices) and are identified as follows:

- Trace Impurities in Bulk Gases Incorporating the Amperometric Sulfur Detector (007016_03)
- Trace Impurities in Beverage-Grade CO2 Incorporating the Amperometric Sulfur Detector (007016_02)

## PerkinElmer and Arnel, Inc.- The Perfect Combination for the Best GC Separation

That plan has produced more than 100 innovative standard analyzers, systems and accessories, plus custom systems which have greatly increased the customers' analytical options.

PerkinElmer-Arnel standard and custom analyzers are turnkey solutions with defined specifications that cover a wide range of applications and requirements for many industries. Laboratory and plant-based products for occupational safety, quality control (QC) and process monitoring are available for petrochemical, food & beverage, pharmaceutical and other industries. Under the agreement, all PerkinElmer-Arnel products are sold, serviced and warranted worldwide as PerkinElmer products, providing single-vendor responsibility. Since the inception of the agreement, more than 1400 products have been sold worldwide.

Some of the application-specific solutions provided by PerkinElmer-Arnel are listed below:

- Amperometric Sulfur Detection (ASD) Systems
- Refinery/Light Hydrocarbon Gas Analyzer
- Detailed Hydrocarbon (DHAX) Analyzer
- Liquid Expansion Apparatus
- Trace Light Gas Analyzer
- Trace Impurities in Beverage-Grade CO2 Analyzers
- Simulated Distillation Analyzer
- Transformer Oil Gas Analyzer Systems

### Custom Solutions

PerkinElmer and Arnel can also provide answers for chromatographers who require custom solutions or have special sample-handling or software considerations. Arnel's add-on products and enhancements, plus expertise and experience, are there to aid you and provide a guaranteed solution. Determining the exact system solution to meet your needs is achieved by completing an Application/Engineering Questionnaire, which details your requirements for technical evaluation. Once the guaranteed solution is determined and quoted, the entire system is sold, serviced and warranted worldwide by PerkinElmer.

### About Arnel

Arnel Inc., which was established in 1982, is a technology company with expertise in sample handling, plus diverse trace- and percent-level chromatographic analysis. As an innovator in the manufacture of quality-control and process-monitoring analyzers and indoor air-quality monitoring systems, Arnel strives to meet industry standards and specifications with the best cost for performance.

Today Arnel specializes in batch, plus on-line single or multi-point analyzers and systems for automatic, attended or unattended operation in environmental, research, quality control and process areas in many industries.

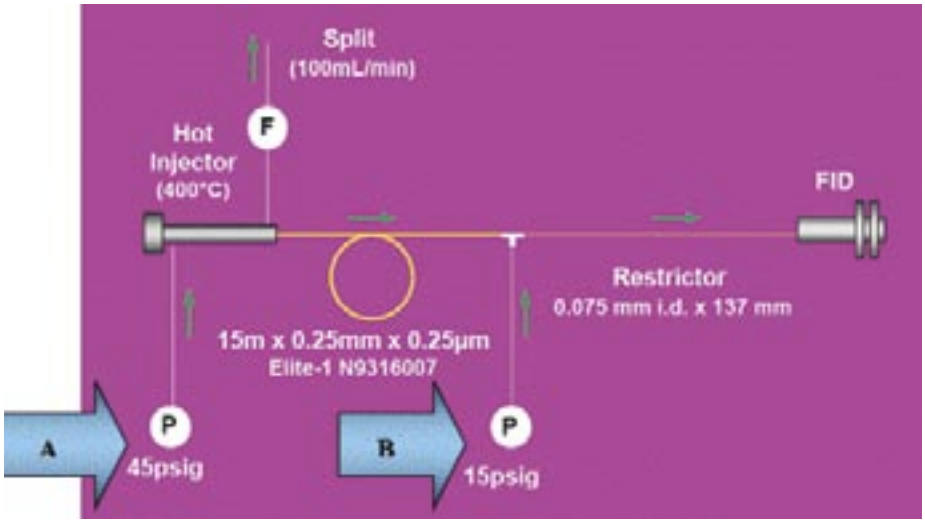
PerkinElmer and Arnel are here to provide the guaranteed analyzers, systems and accessories to meet your requirements. We are truly the perfect combination for the best GC separations.

*For more information on PerkinElmer-Arnel turnkey solutions, go to www.perkinelmer.com/arnel.*

## A Better Way to Analyze Fuel Diluents in Lubricating Oils

In fairness to flash-point analysis, it is a time-proven method that has served hundreds of laboratories well for many decades. The method is, however, slow and very labor intensive. For laboratories running hundreds of samples per day, the need for a rapid and automated method for performing such analyses is critical, if they are to prevent this test from being a major bottleneck in their laboratory. Although GC methods have been used in the past for such analyses, the analysis time was long and the maintenance of such systems was excessively high.

In response to discussions with one of our major customers, PerkinElmer has developed a rapid automated system for analyzing fuel diluents in lubricating oils using a Clarus® GC equipped with our PreVent™ accessory and an FID. Let me, as a person who is renowned for his lack of knowledge in chromatography, describe what takes place within the instrument.




When the sample is injected into the heated injector, a flow of carrier gas is introduced at a pressure of 45 psig at the point identified with the "A" arrow in the figure below. The volatile diluents are carried through the chromatography column and measured by the FID ahead of the less-volatile materials that are contained in the lubricating oils. Just before the less-volatile (heavy components) of the lubricating oil are passed to the detector, where they can cause a variety of problems, the gas pressure at arrow "B" is increased to 58 psig and the gas pressure at arrow "A" is decreased to 2 psig. This results in a back sweep of those heavy components where they are removed from the instrument and are not allowed to collect inside of the GC. The entire analysis is performed isothermally so that time is not consumed with oven heat-up and cool-down.

Analysis of many samples from our customer has shown that this newly developed method provides results that are comparable to established methods and our method can be completed in about 3.5 minutes. The method is automated, extremely rugged and requires no sample preparation.

An application note is being written (by chromatographers) that provides more technical information on this new method. You can contact your local PerkinElmer representative and ask for the Field Application Report entitled "A Novel Method for the High-Speed Determination of Fuel Diluents in Lubricating Oils" or check our website at www.perkinelmer.com/petrochem to download a PDF of this application note.

## Indy Racing League Update

For those of you who follow the Indy Racing League (IRL), you probably already know that the IRL 2005 season is off to a great start. Several of the first seventeen races are already completed with the exciting Indy 500 last May 29. There are many more to go (see schedule below). If you wish additional information on the upcoming races, it can be found at www.indycar.com.

Most people, including chemists, who visit an IRL race track, are surprised by the amount of testing the IRL performs on the race cars. As part of that testing, PerkinElmer supplies the testing equipment – a Clarus® Gas Chromatograph - that is used to test methanol, the fuel used in the cars. This test is used to confirm that no accelerants or other materials have been added to the fuel. Additional testing is performed by FTIR on the oil used in the car to assure that it complies with the specifications of the manufacturer. The atomic absorption spectrometer shown in the picture (AAnalyst™ 200) can be used to look for wear metals in the lubricating fluids and to perform other elemental analyses. For the largest IRL race which is held in Indianapolis, there is an actual lab setup in Gasoline Alley which is shown in the picture below. For the other US races, the laboratory is contained in a mobile facility taken to each race.

There is news from the track this year – the fuel used in the cars will be switching from natural gas-produced methanol to home grown corn-derived ethanol in 2006. Perhaps it is surprising to learn that gasoline has not been used as a fuel at Indy since the 1970s.

| Date | Day | Track | Network |
|---|---|---|---|
| March 6, 2005 | Sunday | Homestead-Miami | ESPN |
| March 19, 2005 | Saturday | Phoenix | ABC |
| April 3, 2005 | Sunday | St. Pete | ESPN |
| April 30, 2005 | Saturday | Twin Ring Motegi | ESPN |
| May 29, 2005 | Sunday | Indianapolis | ABC |
| June 11, 2005 | Saturday | Texas | ESPN |
| June 25, 2005 | Saturday | Richmond | ESPN2 |
| July 3, 2005 | Sunday | Kansas | ESPN |
| July 16, 2005 | Saturday | Nashville | ESPN |
| July 24, 2005 | Sunday | Milwaukee | ESPN |
| July 31, 2005 | Sunday | Michigan | ABC |
| August 14, 2005 | Sunday | Kentucky | ABC |
| August 21, 2005 | Sunday | Pikes Peak | ABC |
| August 28, 2005 | Sunday | Infineon - Sonoma, CA | ESPN |
| September 11, 2005 | Sunday | Chicagoland | ABC |
| September 25, 2005 | Sunday | Watkins Glen, NY | ABC |
| October 16, 2005 | Sunday | California | ESPN |

## Das Schlosz der Hohenzollern (Sigmaringen Castle)

An especially beautiful part of Europe is the area where Germany, Switzerland, and Austria meet. This juncture is covered by the 539 square kilometer Lake Constance - also identified as the Bodensee – which occupies a basin in the Rhine River and adds to the scenic beauty. The area around Lake Constance is surrounded by vineyards, orchards, churches and ancient castles. A two-hour bicycle ride (as taken by an aging author) from Lake Constance brings you to Sigmaringen Castle which is also known as Das Schlosz der Hohenzollern. It is believed that the area on which the castle stands may have once held a Roman structure. Although we cannot be sure just when the Sigmaringen Castle was constructed, it is mentioned for the first time in the chronicle kept by the monks of Peterhausen in 1077. The castle has a long history that is too involved to detail in this short article. The history is punctuated by a series of attacks from various enemies over the centuries, followed by an almost equal number of rebuilds. The Counts von Werdenberg, who extended the castle to cover the ground of the current structure in the late fifteenth century, were perhaps the most enthusiastic rebuilders. The castle was destroyed during the Thirty Years' War and was later rebuilt by Prince Meirad I. The castle was destroyed once again by fire in 1893 and was rebuilt shortly after that. Since some of the older structures remain despite the impact of wars and fire, a tour through the castle reveals architecture that spans nearly 1000 years. The tall tower standing above the other structures in the picture shown in this paragraph is thought to be from the 12th century. This castle played an important role in the history of Europe when Count Karl I von Hohenzollern, who was a trusted advisor to several German emperors, united the entire Hohenzollern wealth at this site in the sixteenth century.

Although filled with many interesting and often unusual rooms, there are two that seemed to capture the interest of nearly every visitor. The Ancestral Hall, which was built in 1736, contains twenty-six paintings of the ancestors of the Counts and Princes of Hohenzollern. It is not clear what one had to do to have their portrait hung in this hall. However, it was noted that the last head of the family to die was always given a space in the Ancestral Hall. In a cartouche on the ceiling stands the device of the House of Hohenzollern: "Nihil sine Deo" – Nothing without God.

The Amory is housed in the basement and contains weapons from the past six centuries. Many suits of armor from the 16th, 17th and 18th century are exhibited and, in my opinion, not one of them looked even marginally comfortable. Firearms ranging from crossbows, matchlocks, flintlocks and wheel locks through to weapons used in World War II were all on display. This armory represents one of the largest collections of weaponry in all of Europe.

The castle, located in an exceptional part of Europe, offers wonderful vistas, centuries of architecture, a thorough history of the Hohenzollern dynasty and many other interesting items of study. It is an attraction worth putting on your list of places that you may wish to visit someday.