Analytical Capabilities at Air Products

Air Products and Chemicals, Inc.

Scratch your head about the cause of failure in your products? Wonder why the process is not working? When you need help with troubleshooting and problem solving, did you know that the technical specialists at Air Products are ready to assist you?

To help Air Products' customers, our commercial representatives draw upon their industry knowledge and experiences, as well as Air Products' strong internal analytical expertise. The company's Global Analytical Science (GAS) department has built comprehensive analytical capabilities for R&D development and customer support through more than 40 scientists (30% with PhDs) and $16 million of capital equipment. GAS works closely with other Air Products' internal specialists to help provide rapid, accurate and thorough solutions to characterization problems.

GAS covers the broad analytical needs of R&D, customer services, engineering and manufacturing processes. Our capabilities for chemical characterization (product composition, concentration quantification, and impurity and contaminant identification) include wet organic and inorganic techniques for functional group and elemental analysis; a wide range of chromatographic methods for gas, liquid and polymers separation and characterization; spectroscopic techniques including IR, Raman, UV-VIS and Fluorescence; NMR and mass spectrometry for chemical identification; and, rheology and thermal analysis for understanding how materials behave when subject to physical stress or heat.

Our sorption capabilities measure properties including pore size and distribution, active surface area and permeability. This information is vital for characterizing gas separation materials and membranes, catalysts and thin films in order to develop suitable application conditions.

The materials engineering capabilities perform failure analysis, fractographic examination and materials selection with a variety of metallographic and portable tools.

GAS also features numerous state-of-art instruments for measuring the chemical and physical properties of surfaces. If you want a picture of your surface, our secondary electron microscopy (SEM) can produce images with nanometer resolution. Perhaps the surface topography is of interest; both optical profilometry and atomic force microscopy generate images with roughness measurement. When chemical composition of a solid material is desired, energy dispersive spectroscopy (EDS) is a quick scanning tool for elemental analysis in near surface range while both X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (TOF-SIMS) obtain more chemical information from the topmost surface of materials with 0.1% to parts-per-million sensitivity. For measuring residual stress and phase change in a material after rolling, welding, grinding or similar processes, our X-ray diffraction (XRD) is the tool of choice.

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Thin film thickness can be obtained using ellipsometry or X-ray reflectivity, whereas electrical methods such as impedance, four-point probe and quartz crystal microbalance (QCM) can monitor in-situ film formation and removal in real time.

Each technique has its unique value in terms of sensitivity, resolution, sample specifications and speed, yet many of them are complementary to each other. One role of our analytical scientists is to understand your application and analytical problem and use our knowledge to recommend the technique or a combination of techniques to help you solve your challenge.

For example, a manufacturer of stainless steel components encountered some surface discoloration. Initially, they consulted with an external lab which conducted SEM (scanning electron microscopy), EDS (energy dispersive spectroscopy) and metallography analysis but could not detect any chemical differences between the good and bad samples. As a supplier of gas to this manufacturer, our commercial representative brought the issue to GAS. Realizing the discoloration was more surface-specific, our scientists chose XPS (X-ray photoelectron spectroscopy), which measured a full spectrum of elemental composition quantitatively from the topmost monolayer of surface. The XPS experiments evaluated a group of elements on both samples as received and after a light ion sputtering to remove any possible adventitious contamination, the results revealed a much higher level of fluorine levels in the “bad” sample. Once we understood that fluorine was causing the discoloration, we looked upstream in the production process and identified and rectified the source of the fluorine contamination.

In another case, a building maintenance products and industrial lubricant producer had a large quantity of black powder formed in their weld process, and GAS scientists were involved in identifying this soot-like material. A thermal analysis technique, DSC-TGA (differential scanning calorimetry - thermalgravimetric analysis) was used to measure the weight of the powder as it was heated to 1000 C. This experiment showed that 90% of the weight was retained, ruling out a significant presence of hydrocarbons. In addition, Raman spectroscopy was conducted and a major peak at 640 cm^{-1} was assigned to magnetite (Fe_3O_4). Combining results from both experiments, it was concluded that the black powder was comprised of 90% metallic particles with the remainder carbon. The likely cause of this issue being the very high power levels used to weld the thick cross sections.

In addition to providing analytical support to current customer challenges, scientists in GAS also work closely with our metallurgists and engineers to develop new capabilities and identify novel techniques such as on-line process monitoring. At Air Products, we are committed to using our experience to bring more and valuable offerings to support our customers.

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