CASE STUDY

Environmental Analysis

UMBC's New Paradigm for the University Laboratory Provides Latest Scientific Technology

The University of Maryland Baltimore County (UMBC) Molecular Characterization and Analysis Complex (MCAC) provides an interesting new paradigm for how universities can structure a laboratory as a service center to the university as well as to local companies and government agencies in order to upgrade its capabilities. "In the university laboratory of the past, equipment was primarily purchased by a single faculty member for a specific project," said Dr. William R. LaCourse, Dean, UMBC, College of Natural and Mathematical Sciences. "With the MCAC we have established a new model where the laboratory is conceived to service the wider university community as well as local businesses and government bodies on a fee-for-service basis. This approach provides a consistent source of revenues that helps justify the purchase of more advanced scientific instruments that deliver capabilities that could never be justified under the traditional model. Our students gain access to latest technology which helps to better prepare them for jobs in industry and academia."

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For the Better

Established as a part of the University System of Maryland in 1966, UMBC specializes in the natural sciences and engineering while also offering programs in the liberal arts. In 2012 for the third year in a row, UMBC topped the U.S. News Best Colleges ranking category of universities that are making the most promising and innovative changes in the areas of academics, faculty and student life. U.S. News also ranks UMBC fourth on a list of the top national universities "where the faculty has an unusual commitment to undergraduate teaching." UMBC is tied with Yale University and ranks just ahead of Brown and Stanford universities in this category.

Traditional university lab model

The previous UMBC approach where equipment was purchased by a particular faculty member provided minimal access to the equipment for the rest of the university community and rarely was any effort ever made to provide services to the broader community. There was typically no support structure in place to train other students in using the equipment or to even make them aware of its existence. The old approach was also inconvenient for users because they had to bring all of their own materials such as beakers and pipettes. Individual faculty members usually did not have funding to purchase the latest instrument technology, so users typically had to make do with older, lower-end equipment. Recent cutbacks have made it hard in many cases for individual faculty members to obtain funding even for lower-end equipment.

New model pioneered at UMBC

Dr. LaCourse conceived a new model in which the laboratory operates as a service center for the university and actively markets itself to outside organizations. "We make our equipment available to all departments in the university as well as neighboring businesses and government agencies on a fee per use basis," he said. "Making the laboratory customer friendly was critical to the new approach. Josh Wilhide, the Mass Spectrometry Facilities Manager was appointed to his position to oversee the MCAC as well as train its users to run the instruments. We put in cubicles for people to work in and provide glassware and other supplies so they do not have to bring their own."

The MCAC emphasizes mass spectroscopy because its powerful capabilities create considerable demand for the equipment in both the university and business community. Soon after the creation of the MCAC, the lab purchased its first piece of PerkinElmer equipment and over time a relationship has blossomed. "To me, mass spectrometers from different instrument manufacturers are largely similar in their technology," Wilhide said. "But PerkinElmer has also been very focused on developing their instruments to make them easier and faster to use. As a general rule, I find that it takes me 30 minutes to train a student or a customer to use a PerkinElmer mass spectrometer vs. 2 hours with competitive instruments. The ease of use of PerkinElmer mass spectrometers helps our students quickly master complex technology for their assignments and research and makes it more likely that our customers will achieve the results they are looking for."

DSA source attached to AxION 2 TOF.

Value of direct sample analysis

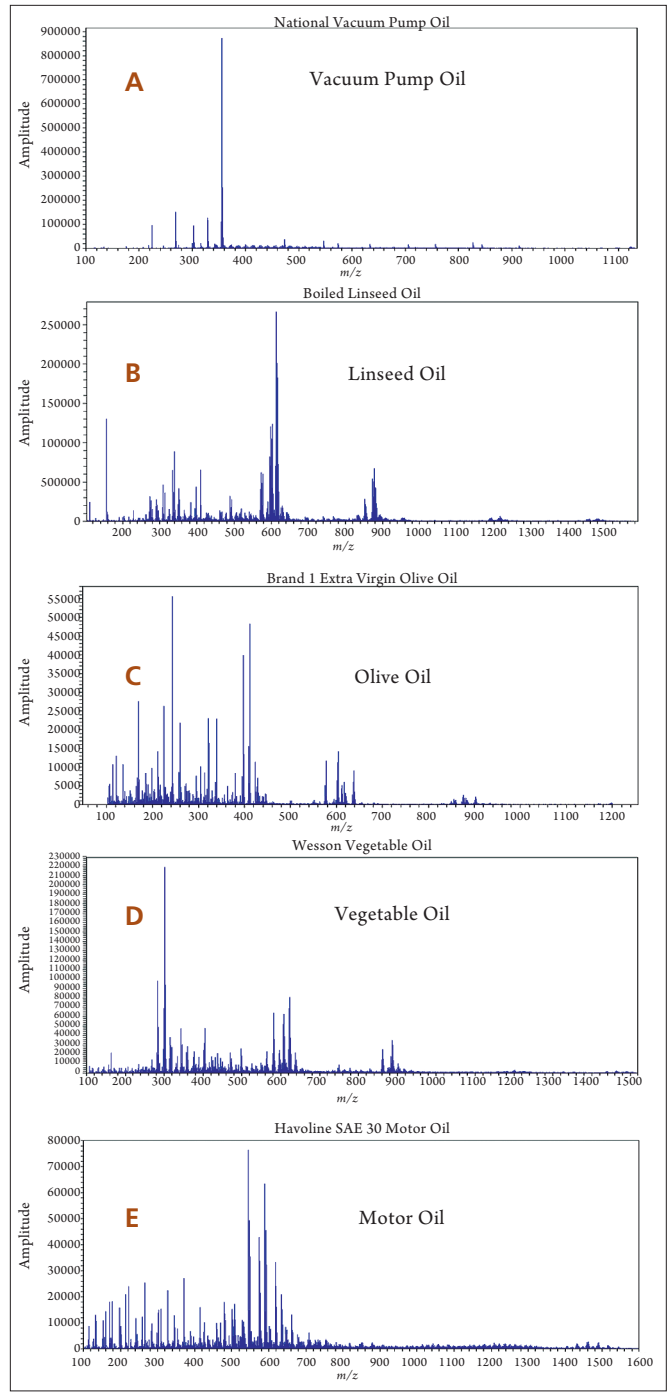
Wilhide said that the direct sample analysis (DSA) provided by PerkinElmer AxION® DSA™ system has been a big hit at the MCAC. DSA makes it possible to run virtually any sample directly through a time-of-flight (TOF) mass spectrometer without the need for up-front chromatographic separation, method development or sample preparation. Ionization occurs within the enclosed portion of the DSA system, at the entrance to the mass spectrometer, generating clean molecular ions without any of the complex, time-consuming steps traditionally required. By eliminating those multiple steps from the workflow, analysis time on average can be reduced from 25 minutes to 25 seconds. Switching between a DSA and a liquid chromatography (LC) system can be done in just two minutes without breaking vacuum. PerkinElmer is the only instrument supplier that has designed a DSA and TOF from the ground up to work together from a single software package, which makes them easier to use, and allows both to be completely enclosed to provide greater sensitivity and increased safety.

Wilhide said that one area where the lab's customers have taken advantage of DSA is analyzing thin layer chromatography (TLC) samples. The traditional approach is to run a separation on a gravity column and then use a nuclear magnetic resonance (NMR) spectrometer to identify the various compounds. This method takes several hours. "Instead, we take the TLC plates and load them on the DSA, push a button and get the answer in about six seconds," Wilhide said. "By reducing the amount of time required to analyze a sample, DSA enables our mass spec instruments to accommodate more users and samples."

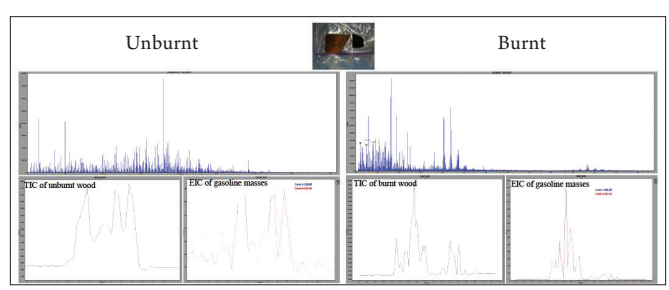
The Maryland Department of Business and Economic Development provided the MCAC with a grant to purchase a PerkinElmer AxION 2 TOF mass spectrometer, which provides several unique aspects that complete the previously diverse mass spec facilities at UMBC. In the announcement that it had purchased the instrument the MCAC said: "The virtually unlimited acquisition rate and infinite mass range sets this instrument apart from others at the MCAC. The increased acquisition rate allows for the minimal loss of analytes while running in online mode with ultra high performance liquid chromatography (UHPLC), which increases the sensitivity of the method." Wilhide added: "In the past we used instruments that qualitated and instruments that quantitated, We had to train users on both and run many samples through both instruments. The AxION 2 TOF does both, which saves on training and analysis time."

Customer applications

"Our facility is equipped to do just about anything," LaCourse said. "To date, forensics, environmental and food safety have been the three biggest applications of our outside customers." In one typical example, the MCAC demonstrated its ability to perform rapid and unambiguous identification of flammable oils to help identify the cause of fires. The PerkinElmer AxION DSA ion source was mounted to a PerkinElmer AxION 2 TOF mass spectrometer. Reagent ion gas composition, flow rate, temperature, countercurrent heated gas flow rate, and purge gas flow rate were adjusted through software controls for optimum conditions. Liquid oil samples were introduced into the ion source individually on screens which were mounted on a two-axis translator with sample position controlled through software. The results showed the ability not only to identify different types of oils, but also to distinguish between different manufacturers' versions of the same product.



Distinguishing between different oil products.

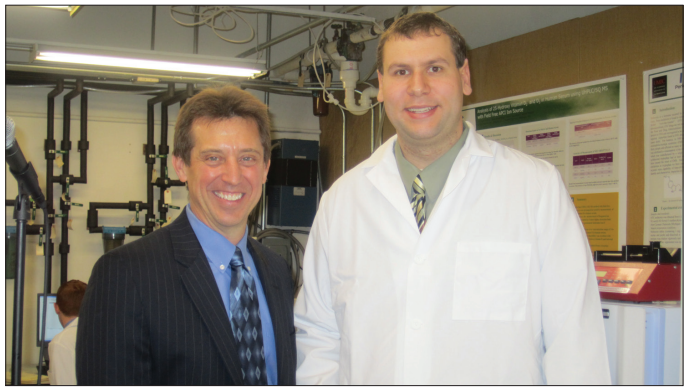


Extracted ion chromatograms show *m/z* associated with gasoline.

The MCAC also analyzed a variety of post petroleum combustion components on common household building materials in order to demonstrate its ability to provide rapid screening of samples taken directly from a fire. A spectrum of each unburned sample was used as a control. Samples were doused with gasoline and allowed to burn until the sample was self extinguished. Each spectrum was obtained by holding the material directly in front of the DSA ion source with no sample pretreatment. The extracted ion chromatogram (EIC) showed *m/z*'s of 108 and 112 which were determined to be associated with gasoline. Gasoline was successfully identified in each sample that had been burned to completion using gasoline. Masses identified in the burned samples were shown to be from gasoline and not the combustion process.

"The MCAC is all about upgrading the capabilities of the university to provide students and researchers with access to the latest analytical technology and bringing the same technology to businesses and government agencies in the area," LaCourse concluded. "Our lab has focused first on getting leading edge analytical methods and second on implementing business processes that will allow us to efficiently service our clients' needs. The next step will be an increased focus on marketing our services to potential customers in our area. Our partnership with PerkinElmer has played a key role in our progress to date and we see it as key to our future growth."

MCAC lab where students and researchers have access to the latest analytical technology.



PerkinElmer's Dusty Tenney, President, Analytical Sciences and Laboratory Services with Josh Wilhide, UMBC's Mass Spec Facility Manager.

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