■ DIAGNOSTIC INSTRUMENTATION & ANALYSIS LABORATORY ■

DIAL ~ *Serving The Glass Industry*

CAPABILITY STATEMENT FEBRUARY 2001

The Diagnostic Instrumentation and Analysis Laboratory (DIAL) at Mississippi State University is a multidisciplinary group of scientists and engineers focused on measurement and testing. DIAL's projects span the energy, environmental, infrastructure, and industrial process arenas. Since its beginning in 1979, DIAL has been a leader in the monitoring, testing, and control of high-temperature processes. Currently, DIAL has several programs that address glass industry needs. These range from characterization of operating glass melters, to development of advanced monitors for process control, to pilot plant testing of innovative processes.

GLASS FURNACE CHARACTERIZATION

Many in the glass industry are facing an uncomfortable choice between capital spending for new process equipment and simply maintaining what they have. DIAL can help make that choice easier by helping the industry to understand what is happening in their furnaces and auxiliary equipment, and pinpoint areas for potential improvements.

For example, over the past two years, a team of DIAL personnel has carried out successful campaigns to characterize the conditions inside an operating lead glass furnace. The DIAL team has measured glass surface temperatures, furnace wall temperatures, glass surface velocity, and the radiative heat flux from five different directions. Gas temperatures, velocities, and compositions were also determined. These measurements required development of custom probes able to withstand the high temperature environment (ca. 1600˚C) inside the furnace. The furnace operator is using this data to better understand furnace operation and thus optimize performance.

This characterization extends to the furnace itself. DIAL scientists have used spectral imaging techniques to characterize both the melting process (e.g., heat-up of batch), and the temperature profile of operating equipment. For example, DIAL's mini-VIP (miniature visible probe) system was developed to image the combustion space inside an operating furnace. This system – consisting of custom hardware and software - was developed for and has been successfully tested at TVA's Bull Run (TN) coal-fired power plant. As another example, DIAL's thermal imaging systems have been used in a commercial glass furnace to measure the temperatures of the refractory surfaces and the glass melt surface.

DIAL can also characterize the emissions from an operating glass furnace. DIAL carries out these tests in conformance with EPA protocols either at its own facilities or those of its customers. For example, DIAL performed EPA emissions testing as part of an evaluation of a

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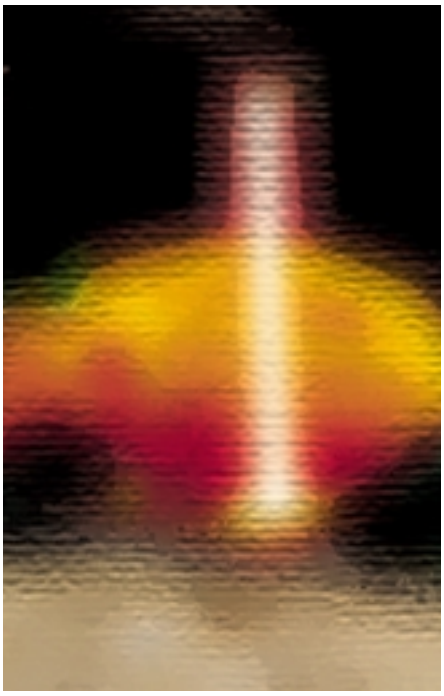
hollow electrode plasma arc vitrification system at Montec in Butte, MT. The emissions testing was successful, as evidenced by the comparability of the results of these tests with others on similar systems, thus demonstrating DIAL's ability to test in accordance with EPA protocols.

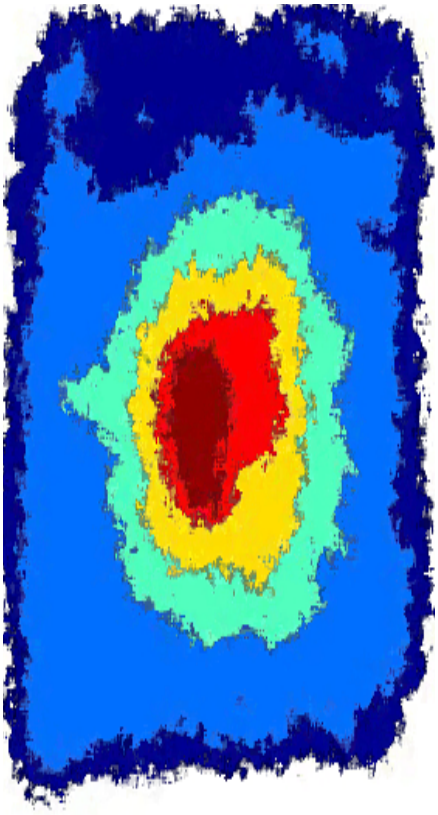
ADVANCED MONITORING TECHNOLOGIES

DIAL has extensive experience in developing custom instrumentation for monitoring high-temperature processes. An excellent example is its Laser-induced Breakdown Spectrometer – LIBS – for use as an *in situ* monitor of the composition of glass. DIAL has already demonstrated that LIBS can be used to monitor the composition of molten glass as it exits the furnace, and is currently testing a probe that will allow it to be used to look at the composition of glass in furnace or forehearth. The DIAL team is also modifying its LIBS system so that it can be used to monitor composition of feed materials before they enter the furnace.

DIAL has adapted standard Raman spectroscopic instrumentation to make measurements inside a glass furnace. Using this technique, DIAL engineers have measured the gas temperature on a real time basis. DIAL personnel have also used this technique to determine the composition of gas in the vapor space in a chemical reactor operating at combustion temperatures.

Imaging of high-temperature systems is one of the best – and often is the only – means to control thermal processing equipment. DIAL has used its systems to assist industrial customers such as Dow Chemical and TVA in viewing high-temperature features of installed plant. For example, DIAL provided a viewing system to help guide plasma torch operations at Argonne National Laboratory-West. In a seven month period, DIAL built a system, prepared an operating manual, delivered the system and documentation to ANL-W, and participated in initial testing. This work was completed on time, and within the budget allotted for it. This demonstrates DIAL's ability to deliver systems which enhance the operability of high temperature equipment, in a timely and cost-effective manner.





DIAL has developed a suite of monitors capable of continuously measuring components emitted from combustion processes in real time. Two of DIAL's monitors, its LIBS system and its air-inductively coupled plasma spectrometer – Air-ICP, were tested along with four others at the EPA's test bed in Raleigh, NC. Both of DIAL's systems performed admirably. DIAL's systems were the first to complete setup, testifying to the field-worthiness of their design and construction. During testing, the DIAL systems were the first to signal that the EPA test-bed was not at steady-state, contrary to the expectations of the EPA staff. Further, the instruments yielded values of total emissions which were within the experimental error of values obtained from EPA reference methods. It should be noted that DIAL's instrumentation did not experience any significant downtime.

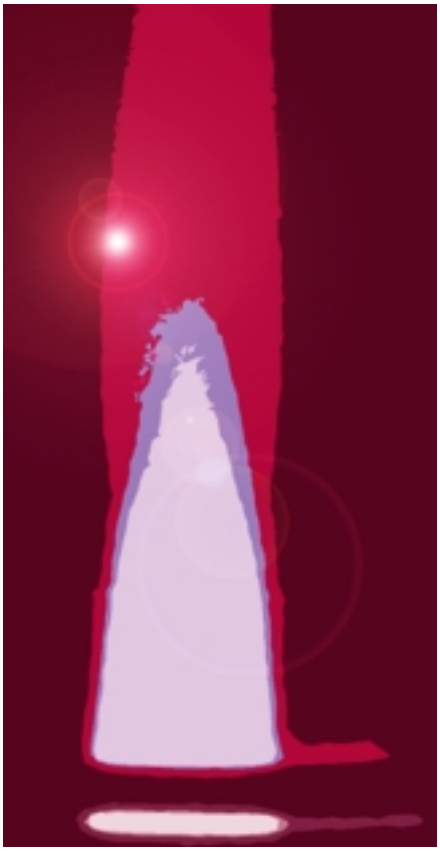
DIAL is currently developing cavity ring down spectroscopy (CRDS) as a continuous emission monitor (CEM) for both metals and important organic species, such as dioxins and furans. DIAL's CRDS technology offers an extremely sensitive, on-line, real time method for measuring the concentrations of these

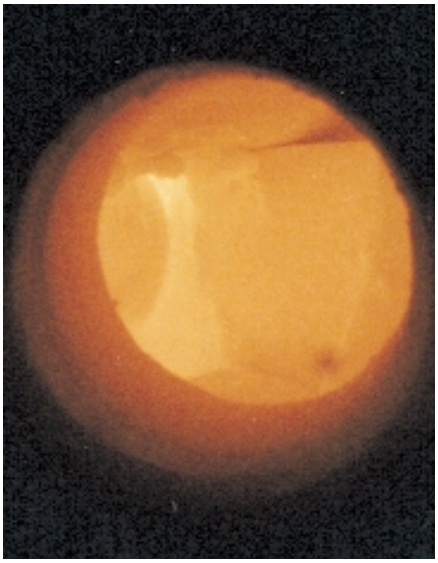
species in a package which promises to be more reliable than the current state-of-the-art instrumentation.

TESTING AND PROCESS DEVELOPMENT

DIAL has recently assisted in development of two glass-making processes. In the first, DIAL worked with a foreign organization to demonstrate the performance of an innovative hybrid furnace utilizing both plasma and induction heating technology. DIAL is currently working with a small company to develop a highly unusual process for vitrification of nuclear waste. In the latter, DIAL is responsible for all the analytical work and the product testing as well as the operation of the pilot-scale process equipment. In this case, DIAL's state-of-the-art analytical laboratory is turning out analytical data comparable in quality to those generated by the national labs.

In a related program, DIAL recently completed testing of a unique flex-fuel gasifier for Ishikawajima-Harima Heavy





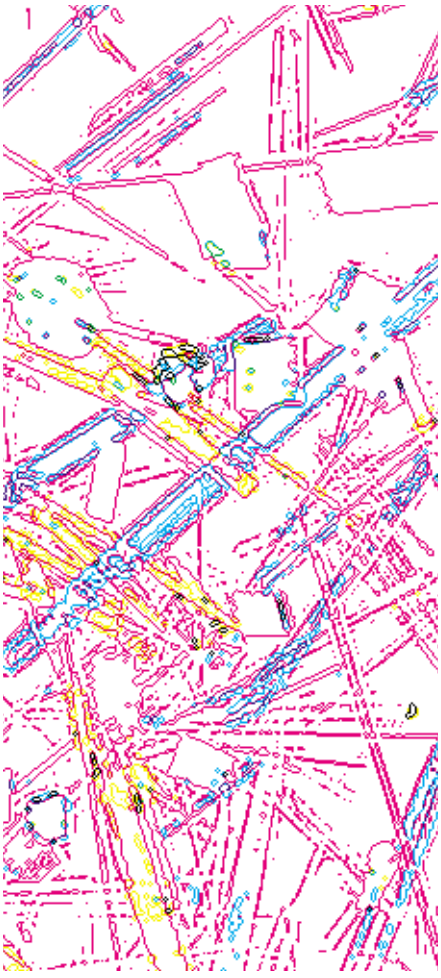
Industries and the Japanese Science and Technology Agency. This effort required the design and procurement of pilot-scale process equipment, its installation in DIAL's high bay facilities, and initial testing of the system. DIAL quickly identified a major design flaw which would have prevented reliable operation of a full-scale facility in the Yokohama prefecture in Japan. Working with their Japanese colleagues, DIAL's team quickly identified the problem, and developed and successfully tested a solution. As a result, IHI avoided a costly retrofit worth about $10,000,000.

Glass manufacturers are facing increasing pressure to reduce emissions. There often is little fact and much fiction about the effectiveness of various pollution control equipment. Little effort has been expended to determine the relative performance of these devices, or to try to optimize their performance. DIAL is carrying out comprehensive tests of several off-gas treatment technologies to achieve these ends. For example, DIAL is currently testing a commercial ionizing wet scrubber to determine its ability to remove particulate and semi-volatile species from high temperature process effluents. Similarly, DIAL is evaluating the performance of a submerged bed scrubber (SBS), and, as part of a working group reporting to both the Environmental Protection Agency and the Department of Energy, is working to develop a better understanding of high-efficiency particulate air filter performance.

DIAL's testing capabilities extend to materials' performance evaluation. The high temperatures inherent in a plasma torch vitrification system place a tremendous burden on the materials of construction of a plasma furnace. Westinghouse Savannah River Co. asked DIAL to test the ability of various metals and refractories to withstand the conditions within such a system. DIAL's testing identified two refractories and one metallic material capable of reliably withstanding the high temperatures.

DIAL's testing is supported by a wide variety of computational tools. Engineering heat transfer and fluid flow calculations played an important role in the test program for the Japanese gasifier.

Before this equipment was fabricated, DIAL engineers determined the convection and radiation heat transfer characteristics of the design to be sure that the test article would produce the required gas velocity and temperature, without



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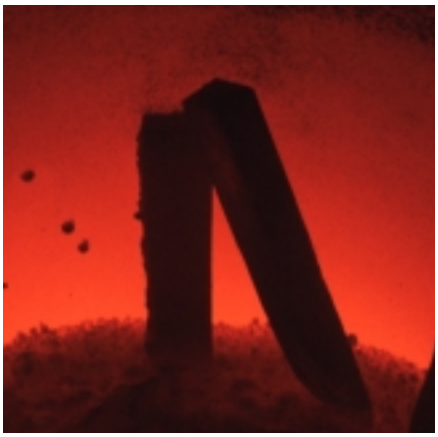
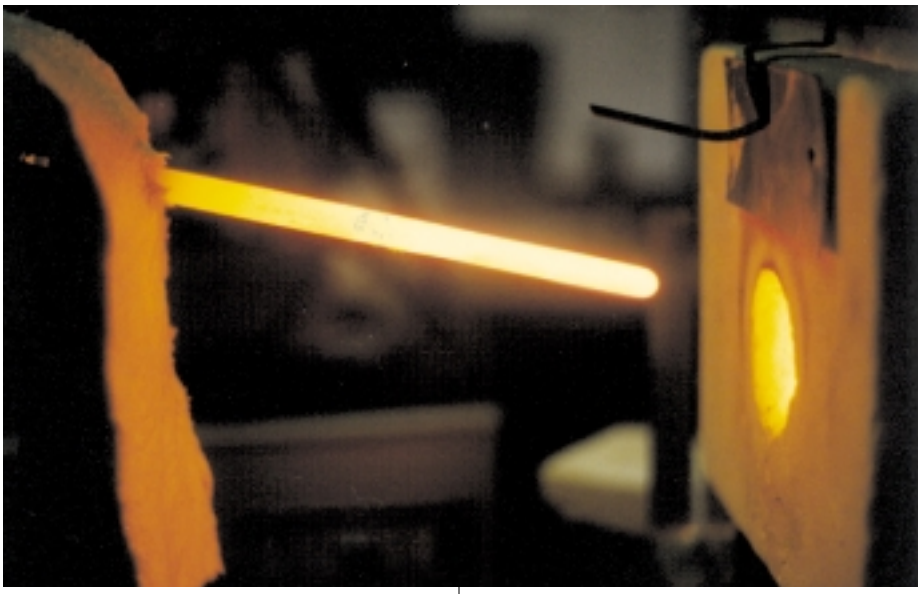
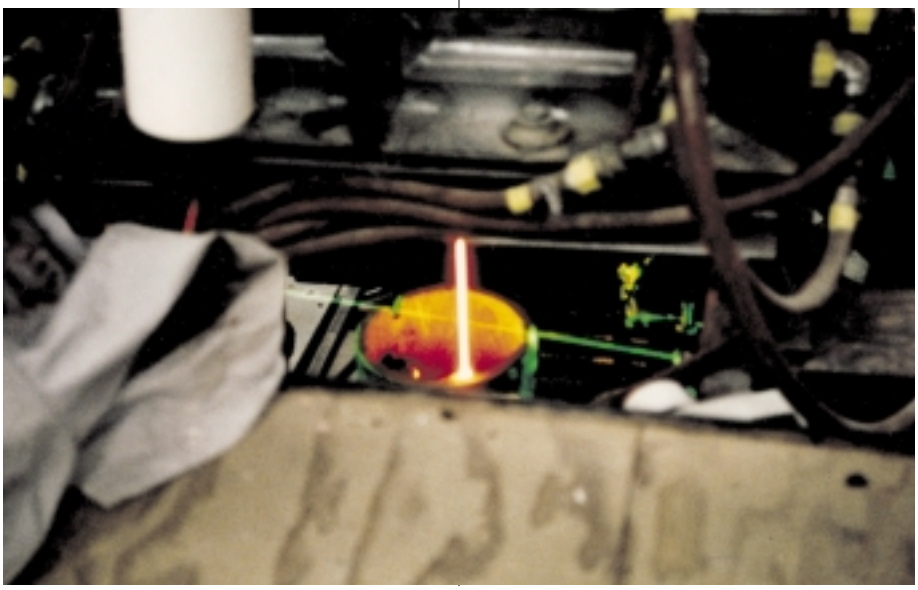
exceeding the temperature limits of the steel outer wall of the vessel. DIAL also maintains an extensive chemical modeling capability which can be used to support testing and development of control schemes.

THE FUTURE

As the preceding has shown, DIAL is familiar with the glass industry's problems, and is working with the industry to provide solutions. Whenever the glass industry needs furnace characterization support, advanced monitors for control, or equipment testing and development, DIAL will be there ready to serve. DIAL is committed to helping the glass industry meet the challenges of the new century, whether environmental, process or product.







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