

Reaction Monitoring

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APPLICATION NOTES

Detector: Reveal XNIR process analyzer
(Extended Near Infrared spectrometer
1100–2100 nm)

Reveal UV process analyzer
(Ultraviolet spectrometer 190–400 nm)



HIGHLIGHTS

- Millisecond measurement times
- Internal referencing, wavelength and linearity validation for stable, continuous operation
- WiFi, Ethernet, OPC, ModBus, Ethernet/IP communications standard
- Hazardous area enclosure options
- Various sampling options



Summary

Real-time, continuous, non-contact monitoring of reactants, intermediates, products, and byproducts of a chemical reaction process can increase reactant utilization, drive product efficiency, and maximize byproduct recovery. Prozess Technologie's Reveal platform is ideally suited for reaction monitoring, with millisecond measurements, a variety of sample interfaces, and rugged system designs for the manufacturing environment.

Reaction Monitoring

Despite accurate controls of feed-stocks and complex mixing and blending procedures, ensuring complete utilization of reactants is practically impossible without analytical feedback on the reaction process. This determination is critical not only to ensuring yield, but is paramount to reducing wasted reactants, time and expenditure. The primary difficulties to implementing an analytical measurement are the fast time rates at which some reactions occur and the interface by which the measurement accesses the process. In many cases, sacrifices are made to allow for slow, multiple-minute analytical measurements such as in gas chromatography, or maintenance-laden fast loops with multi-stage preprocessing such as in mass spectroscopy.

POLYMERIZATION

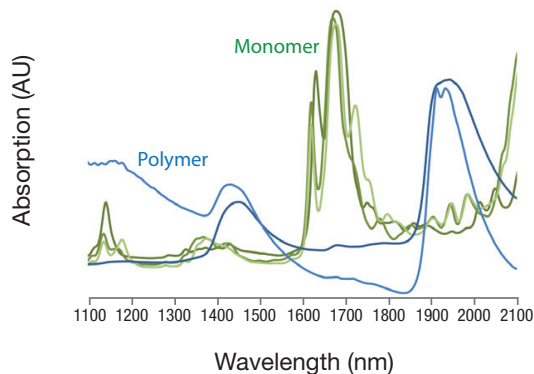


Figure 1: NIR absorption spectra clearly delineate monomer reactants from the polymer products.

SPECIATION

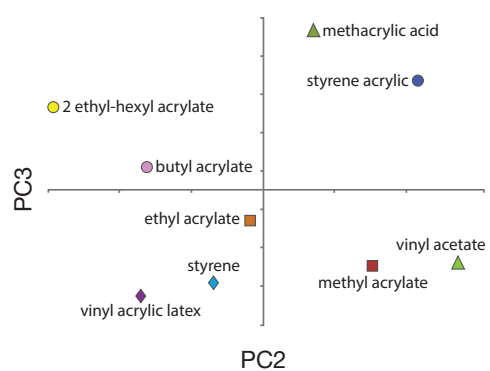


Figure 2: NIR spectra of each monomer allow ready speciation, as shown in these principal component scores derived from the spectra.

Fortunately, in-line, real-time reaction monitoring is possible through optical devices such as Reveal. Both near-infrared (NIR) and ultraviolet (UV) optical spectra can be applied for reaction monitoring. Absorption bands corresponding to each of the reaction components can be used for quantitative measurement of species concentration as well as for semi-qualitative trending to assess reaction completion and homogeneity. Regardless of the optical spectrum utilized, Reveal enables measurements to be made in milliseconds, using sight-glass vessels or flow-cells, to minimize sampling intrusion and provide true real-time feedback of the chemistry.

To demonstrate the reaction monitoring abilities of the Reveal, a flow cell with tungsten-halogen illuminator was used to measure the absorption spectra of multiple reactants (monomers) and products (polymers) for a polymerization reaction. *Figure 1* illustrates the stark contrast between the reactant feed stream and the output products. This clear differentiation allows for straightforward monitoring of the polymerization rate and monomer utilization. Beyond this, *Figure 2* shows the specificity of the optical spectra to the individual monomers, which allows individual tracking of each species throughout the process.

Reveal

The Reveal contains integrated light sources and dispersive spectrometers utilizing linear diode array detectors, with no moving parts for high throughput and maximum stability. The Reveal contains automated internal hardware for lamp referencing and for wavelength and photometric linearity validation, all of which can be performed at user-defined intervals. Standard communications in the system include WiFi, Ethernet, OPC, ModBus and Ethernet/IP for upstream and downstream interface with distributed control systems, computers, or tablets. Sampling options range from flow cells with selectable path lengths, to measuring heads that mate to sight glasses in vessels, to fiber probes for contact or non-contact measurement in various insertion points.

Prozess provides a myriad of engineering solutions to integrate into customers' process streams. Hazardous area enclosures, additional analog and digital inputs and outputs, and sample head integration are just a few of Prozess' competencies to ensure a turnkey and trouble-free implementation. With high stability and genuine real-time measurement, the Reveal is a dependable device for continuous and batch reaction processes.

PROCESS MEASUREMENT
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