Analyzing Carbon Fiber Cure with Coated Sensors

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Carbon fiber forms the basis of products manufactured in industries as diverse as automotive, aerospace, wind power, medical, bath fixtures, sporting goods, and military applications. Without the strength and flexibility of carbon fiber, such products would lack resilience and utility. But manufacturing with carbon fiber can be tricky. Current methods for monitoring cure fall far short of the accuracy needed to ensure finished products meet specifications.

For those working with carbon fiber pre-preg and sheet molding compound, for example in the making of automotive parts, the speed and consistency of cure can be hard to manage. Like with any thermoset material, the only mature method of monitoring cure within manufacturing operations is dielectric analysis (DEA). Other tests for studying cure are limited by being able to be performed under laboratory conditions only.

But the problem with using DEA for studying carbon fiber composites is that the carbon fibers are conductive, so direct contact with these fibers short circuits the electrodes in the sensor. This makes it impossible to take measurements of cure state.

The typical technique to deal with this problem in the laboratory environment is to use a makeshift filter made of laboratory filter paper or fiberglass cloth, which must be done every time a sample of material needs to be tested. Needless to say, this solution is far from ideal. It's a manual operation, which is prone to error and adds time to the testing process.

When parts must be cranked out as quickly as possible (perhaps one per minute) there is no time for additional manual interaction with the sensor. Adding manual effort to each test is completely impractical for manufacturing operations.

With the Lambient Technologies **Carbon+™** sensor, this problem is solved. The **Carbon+** sensor has a thin insulating layer over its electrodes. This enables taking the measurement of cure without the risk of carbon fibers short-circuiting the sensor. The result is a much faster process resulting in highly accurate data about material cure.

What's more, this process can be completely integrated into manufacturing operations. **Carbon+** sensors allow for monitoring the curing of every single part. Users can start acquiring data automatically when the mold closes, and can be confident in obtaining good, actionable data each time. This saves time and money, and allows for better control over part quality.

Carbon+ sensors can be put into a closed loop control of molding operations, which means the sensors provide continuous feedback so that the system can determine when cure is done, and automatically open the mold at the right time. Studies have shown that with this type of closed loop control, a savings in time of 10 seconds on a 60-second operation can be achieved, which translates into an estimated $70,000 savings per year for each mold in a manufacturing operation.[1]

Users can document cure state and can document end cure qualities of the material, which allow for achieving better consistency in end products. With this data, companies can make more solidly reinforced claims about the qualities of the parts they make, in terms of weight, strength, rigidity, color, tackiness, and more.

Having a system like this in place is a huge boon for statistical quality control efforts. It’s far superior to guessing about when parts are cured. Understanding part cure ultimately saves time and improves manufacturing throughput. And with statistical quality control, users end up with more uniform parts, so it’s easier to understand their behavior after finished cure.

[1] *Day, D.R. and Lee, H.L., “Analysis and Control of SMC Part to Part Variations,” Session 13-C of Proceedings of the 17th Annual Conference, Composites Institute, the Society of the Plastics Industry, Inc. (For more information, visit https://tinyurl.com/ybderrov)*

About Lambient Technologies LLC

Lambient Technologies designs and produces instruments for real-time analysis of the curing of thermosets and advanced composite materials such as those used in aerospace, automotive, and wind power applications. Our products offer unique insights into how these materials react and change during curing, processing, and manufacturing. Armed with this critical data, users can proceed with research, quality testing, and final production, confident in the integrity of their processes and materials—and in the reliability of their finished products.

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