ENABLING ADAPTIBILITY IN TODAY'S AUTOMOTIVE AND ELECTRONICS ASSEMBLY OPERATIONS

Next-generation silicone adhesive addresses key bonding needs of automotive industry while providing process flexibility

Our reliance on automotive electronics has skyrocketed since they were first introduced in the mid-1950s.[1] According to a report by Deloitte, electronic systems are expected to represent 50% of a car's total cost by 2030, driven primarily by applications in automation, electrification, digital connectivity, and security.[2]

As automakers continually innovate to meet evolving consumer demands, as well as increasing regulatory requirements, they must develop new features and products as cost effectively as possible. This is easier said than done, particularly when the need to upgrade equipment and processes begins to eat into Return On Investment (ROI).

ADDRESSING AUTOMOTIVE INDUSTRY CHALLENGES

Advancements in automotive manufacturing are being driven by the challenges inherent in the industry's need to address numerous global trends. Automotive and electronics engineers worldwide are all asking similar questions in an effort to find solutions to these challenges.

Can We Reduce Weight without Increasing Process Complexity?

Arguably the most impactful trend is the concept of lightweighting (i.e., improving fuel economy and reducing emissions through the reduction of vehicle weight), which came about as a viable means of meeting various regulatory requirements regarding fuel efficiency. Materials replacement is a common lightweighting tactic. Key examples include the use of plastics to replace metals, as well as adhesives instead of traditional fasteners (e.g., screws and rivets). Materials replacement creates additional challenges, however, including the need to create strong bonds between dissimilar materials such as plastics and metals.

The bonding of thermoplastics can be somewhat problematic in itself due to these materials' low surface energy and the practice of incorporating mineral additives to improve durability and strength. Low surface energy limits an adhesives' ability to wet out on a thermoplastic's surface in order to create a strong bond, while mineral additives often introduce impurities and moisture that can cause defects.

Various methods are available to improve the adhesive bonding of thermoplastics. Processes such as plasma pretreatment can be beneficial in increasing the substrate's surface energy. However, the surface preparation step does result in the need for additional equipment and time.

The issue of embedded moisture in reinforced thermoplastics is somewhat more complex. Two-component adhesives are often cured at temperatures nearing 150˚C, but this often causes problems with bubbling as the moisture escapes to the thermoplastics' surface. As a result, the curing temperature needs to be kept below 95˚C for optimum results.

Can We Achieve a Strong Seal without Adding Process Time?
As the amount of electronics used in automotive assembly continues to increase, the result can be over-crowded electronic casings that are costly and complex to produce. One way to mitigate both of these issues is to use an adhesive instead of screws when sealing the control unit.

Adhesives enable manufacturers to reduce part complexities while saving time and money. They can act as a gasket and provide strong structural support while also eliminating the need to pick and assemble screws.

Ideally, adhesives in electronics assembly should also have the ability to maintain a fast, strong bond during curing and handling in the assembly process. One key example can be found in air leak tests, which are conducted in order to ensure a strong seal. Traditional adhesive solutions have the potential to create a bottleneck since they may require lengthy curing times before these tests can be completed effectively and efficiently.

Can We Ensure a Lightweight, Strong Assembly without Sacrificing Process Flexibility?
As discussed, adhesives have the ability to address multiple challenges in automotive electronics assembly, but the adhesive's curing mechanism can cause delays. Many adhesives require 24 hours or more before they reach the green strength needed for handling and testing.

These bottlenecks cause frustration for many customers that are looking for process adaptability. They need an adhesive that can be cured without heat *and* accelerated with the addition of heat, achieving green strength right away in order to safely continue down the assembly line without causing delays.

DEVELOPING A PROCESS-ADAPTIVE ADHESIVE SOLUTION

The answer to the above questions is "Yes" due to WACKER's development of a next-generation adaptable adhesive. SEMICOSIL® 9820 is a fast-cure, two-component silicone rubber adhesive that offers customers in automotive electronics assembly the high strength and stability they need, combined with the process flexibility they could never before achieve.

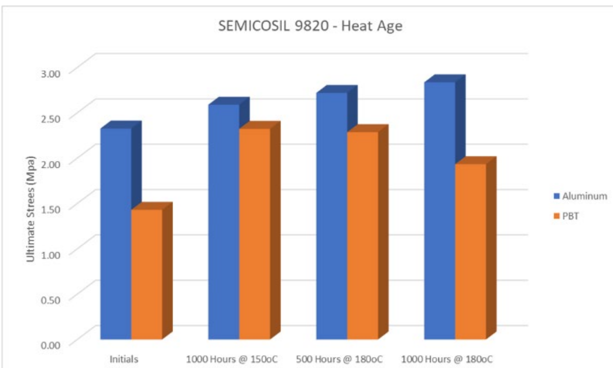
Easy to dispense, SEMICOSIL® 9820 can replace screws and seals in one step, achieving maximum adhesion of 2 MPa on mixed materials. It is compatible with thermoplastics and can be cured at 90˚C or less. In addition, this adhesive has the unique ability to achieve full cure through both ambient and heat-accelerated curing.

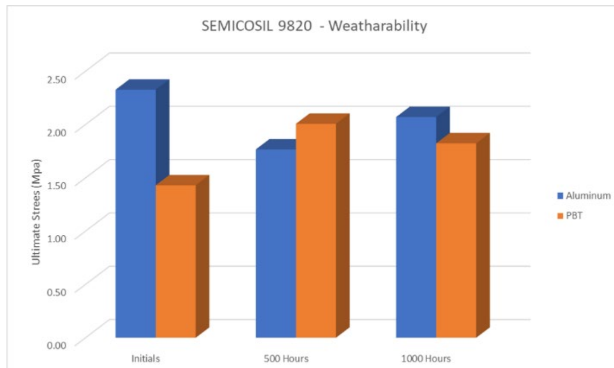
Its fast-cure capabilities mean that SEMICOSIL® 9820 can achieve 1 MPa green strength after curing at 85˚C for just 15 minutes. Full cure can be reached after 30 minutes at 150˚C, and it will continue to build adhesion over time. As a result, customers can have confidence that the adhesive's green strength will enable air leak tests to be conducted almost immediately after application, avoiding bottlenecks and ensuring high-quality seals.

STUDY DETAILS AND RESULTS

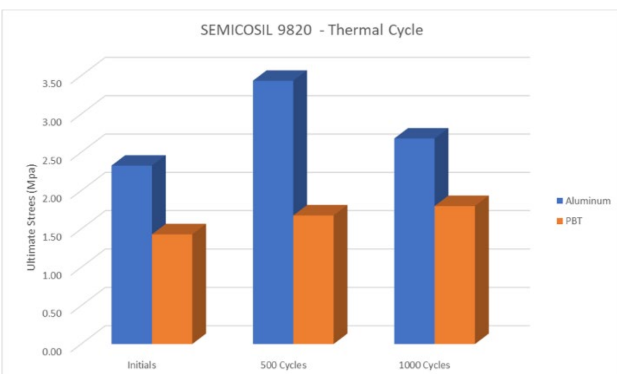
A series of tests was conducted to study SEMICOSIL® 9820's adhesion to aluminum and polybutylene terephthalate (PBT), an insulating thermoplastic that finds widespread use in electronics assembly applications. Single-lap shear tests were conducted according to a modified ASTM D1002-10 standard.[3] All test substrates were cut into 1-in. strips and cleaned with isopropyl alcohol. The substrates did not undergo any additional pretreatment processes (e.g., plasma). The adhesives were applied at 1-mm thick on each sample, with a ½-in. sample overlap.

Tests were conducted to study the effects of heat ageing, weatherability, and thermal shock. Samples in the heat ageing tests were evaluated at 150˚C after 1,000 hours, and at 180˚C after 500 and 1,000 hours. Weatherability tests were conducted at 85˚C and 85% humidity and evaluated after 500 and 1,000 hours. As is evident in the charts below, SEMICOSIL® 9820 maintained its strength on both substrates even during these rigorous testing protocols.





Samples in the thermal shock tests (-45˚C to 150˚C) were evaluated after 500 and 1,000 cycles. The chart below displays the results, illustrating the adhesive's resilience on both substrates.



CONCLUSIONS

The automotive industry is in continual flux. Consumer demands necessitate the addition of complex electronics assemblies just as, conversely, stringent regulations dictate steps such as lightweighting to improve fuel efficiencies. As a result, manufacturers are looking to reduce weight and complexity while simultaneously optimizing production time and retaining flexibility. It's a tall order.

The use of adhesives can address many of these challenges, but not all adhesives are created equal. WACKER's SEMICOSIL® 9820 has the ability to replace traditional fasteners and bond mixed materials while offering the structural strength needed for these high-stakes applications. Its unique adaptable curing mechanism eliminates bottlenecks due to long curing times and allows producers to handle parts almost immediately after the adhesive is applied. As a result, in-line leak testing can be conducted without lengthy delays and customers can have confidence that the parts that pass inspection are strong enough to proceed directly to the rest of the assembly process.

REFERENCES

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