Edited by ***Ryan Gehm***

DSM has ACE up its EPDM sleeve

At a press event near its manufacturing site in Geleen, the Netherlands, **DSM Elastomers** had several announcements to make, not the least of which was that it is still a global leader in the EPDM (ethylene propylene diene monomer) rubber market despite what the supplier's president, Bob Hartmayer, described as "a major revamping of our business" over the last few years.

This restructuring included the closure of two underperforming plants—its sole plants in the U.S. and Japan—and the paring of its product portfolio from 125 to 25 rubber grades. "To counter the loss of production capacity…we have added a new plant in Geleen which is the largest single plant for EPDM in the world," said Hartmayer. The company also increased capacities in its Brazil plant and its remaining two Geleen plants.

On the product side, the major announcement was that in 2008 DSM Elastomers will start producing a line of specialty EPDM rubbers, based on **NOVA Chemicals**' proprietary single site catalyst technology. Branded as Keltan ACE (Advanced Catalysis Elastomers), this new material, which initially will be targeted to high-volume applications such as window gaskets and radiator hoses, meets the two key criteria DSM sets for its advanced catalysis programs, said Herman Dikland, Keltan ACE Business Manager.

"We have identified a 'catalyst cocktail' that is able to produce EPDM products that are currently not attainable with classical types of catalysts," said Herman Dikland, Keltan ACE Business Manager.

"It offers both cost-reduction potential as well as product-differentiation potential," he said. "We have identified a 'catalyst cocktail' that is able to produce EPDM products that are currently not attainable with classical types of catalysts" such as Ziegler-Natta technology.

Keltan ACE contains very high levels of VNB (2-vinyl 5-norbornene) as the third monomer, which limits polymer chain branching and eliminates gelation with this catalyst technology. These high-VNB products respond extremely well to peroxide cures, which "means you can choose to either lower the amount of expensive peroxide to meet a certain performance standard, [or] increase the loading of your compounds while still meeting the same specifications," Dikland explained.

"It is not only the peroxide cure efficiency that makes this product so special; it's also the aging performance," he continued. "The aging of an EPDM product very much relates to the amount of third monomer that you put into a product. If you need less third monomer to create very high cure efficiency, your aging performance is significantly better."

In Keltan ACE, the amount of third monomer can be reduced to as little as 1-3% of the total composition, Dikland noted.

The first full production trials are scheduled to begin in March 2008 at its Geleen site. Full commercialization is expected by early 2009. Dikland noted that DSM is already developing the next two high-VNB products, "because we're targeting a massive market—150 ktpa, which could even be stretched. That will not be covered by one single grade."

Potential applications include gaskets, hoses, belts, seals—"anything that can be peroxide-cured is a target," he said.

Beyond high-VNB products, DSM is working to develop DCPD-containing (dicyclopentadiene) terpolymers that are unbranched, which would be useful in a variety of both sulphur- and peroxide-cure applications. According to Dikland, these DCPD products will not be available before the 2009/2010 time frame.

Ryan Gehm

DSM Elastomers has developed a new line of specialty EPDM rubbers called Keltan ACE (Advanced Catalysis Elastomers), which initially will be targeted to high-volume applications such as window gaskets and radiator hoses.

Silicone TIMs for underhood electronics

Automotive electronic devices are facing thermal management challenges from two directions. Smaller engine compartments are more densely packed with components, raising underhood temperatures. Electronic devices also are offering more functions and power, generating more heat. ABS/ESP control units, for example, used large printed circuit boards in the 1980s. Today, though far more functional, they fit on a thumb-sized ceramic hybrid board.

Device longevity and performance are key objectives today. With underhood electronics temperatures steadily rising, effective heat dissipation is increasingly important. Silicone thermal interface materials (TIMs), available either as dispensed materials or in prefabricated shapes, can improve automotive electronics performance.

When inserted between solid surfaces, TIMs connect the parts—mainly heat sinks and circuit boards—in devices and modules. They also dissipate heat from electronic components, ensuring their reliable, long-term performance. As device makers seek more robust, stable materials to withstand higher temperatures, material suppliers are developing a variety of higher-performing TIMs. Current products include adhesives, gels, encapsulants, gap fillers, and prefabricated pads.

TIMs will play a key role in improving thermal management. Modules and subsystems needing better thermal management include engine and powertrain electronics, vehicle control, lighting and windows, and, recently, hybrid-vehicle modules.

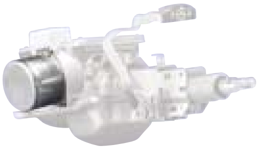
Interface materials' thermal performance depends on three main factors: bulk resistance, contact resistance at the interfaces, and bond line thickness (BLT). Materials developers typically seek high bulk thermal conductivity, low achievable BLT (<100 microns), high electrical insulation, low interfacial resistance, and long-term stability. Also important is assuring close contact with the substrates, which helps eliminate air gaps and maximize heat transfer.

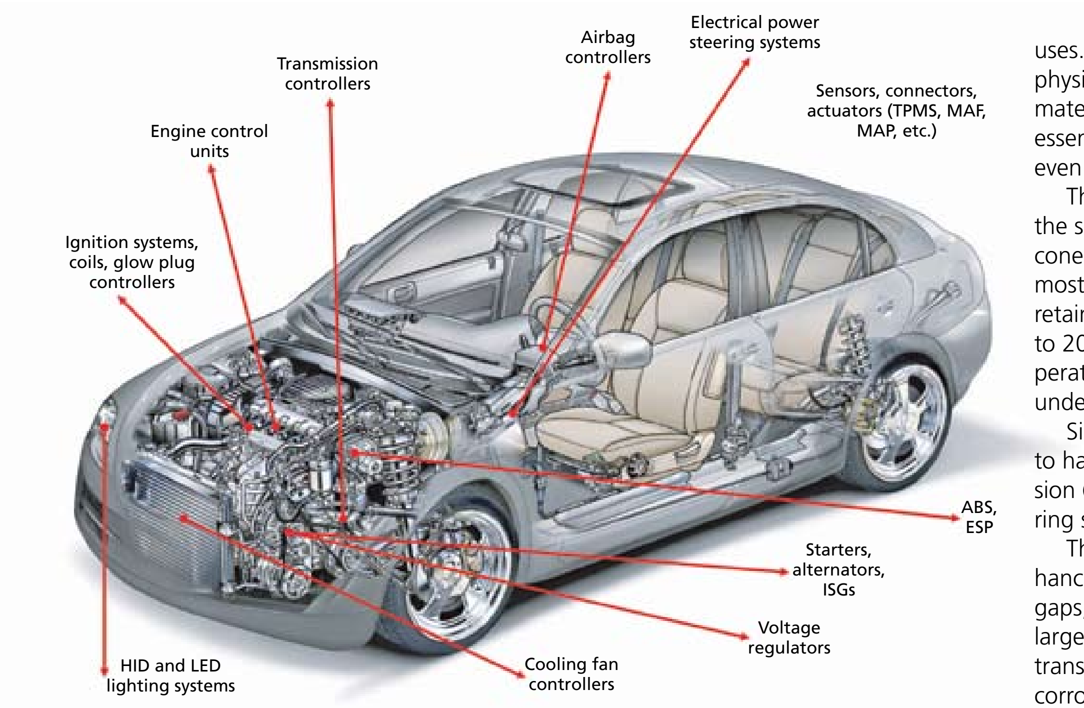
The right TIM can help achieve the best balance of thermal performance, physical characteristics, processing ease, and cost.

Silicones have a long history in thermal applications. Encapsulant use dates back to around 1970, while thermally conductive adhesives have been used in automobiles since the early 1980s.

Silicones' advantages include high- and low-temperature stability, low ionic content, and high purity. They also have low surface energy and are frequently chosen because of their excellent surface contact and void-free substrate interfaces.

Cured silicone materials' physical properties can be tuned for numerous





Thermal interface materials are suitable for use in a number of automotive electronics applications.

uses. Cured silicone typically retains its physical properties better than organic materials. In thermal applications, it is essential to maintain those properties even when highly loaded with filler.

The flexibility, stability, and strength of the silicon-oxygen bond distinguish silicones from organic polymers. Unlike most organic materials, cured silicones retain their physical properties over a 50 to 200°C (122 to 392°F) operating temperature range. This makes them ideal for underhood electronics uses.

Silicone TIMs also are flexible enough to handle coefficient of thermal expansion (CTE) differences without transferring stress to components or substrates.

Thermally conductive adhesives enhance design flexibility. They can bridge gaps, structurally bond, and generate large contact areas to maximize heat transfer. Typical formulations are non-corrosive, heat-cured, one- or two-part materials that develop no significant byproducts during processing and offer thermal conductivity up to 4.0 W/mK. They range from low-viscosity liquids to non-slump formulations.

Thermally conductive silicone adhesives' intimate surface contact reduces interfacial resistance. When cured, they convert to strong, flexible elastomers. They are ideal for harsh underhood environments and are used in engine-control units, brake and suspension controllers, fan controllers, and transmissions. Other suitable uses include power supplies, sensors, and motor controllers.

It is important for interface materials to completely fill surface irregularities and exclude air. The material's bulk conductivity is less critical than its ability to flow and wet the substrate. Although conductive grease makes a good thermal interface, greases are prone to pump-out at high temperatures during repeated thermal cycles. For stress relief, gap fillers are generally softer than adhesives, and can have higher thermal conductivity.

Encapsulants and gels often eliminate excess heat by embedding entire circuit assemblies. Encapsulants cure to a durable elastomer and provide physical protection, while gels are softer and give more relief from thermal expansion and mechanical stress.

Silicone pads—typically 0.1 to 6 mm (0.004 to 0.24 in) thick—are durable and easy to use. They also are among the few repairable materials available. However, they require more BLT than adhesive pads.

Filler material is the heart of any TIM. Alumina, zinc oxide, and other ceramic powders are often used due to their moderate cost and good dielectric properties. Dispersed in the polymeric matrix and balanced for handling, processability, and elastomeric properties, fillers offer bulk thermal conductivity and specific particle morphology (size and shape) and distribution.

In general, the higher a thermal material's filler loading, the greater the thermal conductivity. Maximum filler loading depends on the filler's polymer viscosity and wettability by the matrix. Filler loading and application pressure also factor into BLT.

Particle size is key to determining the BLT, since large filler particles can act as spacers and widen the bond line. TIMs made with smaller particles can achieve thinner bonds and lower thermal resistance. An optimized combination of filler particle sizes can enhance filler loading by up to 50%.

Demand for new materials is increasing along with the thermal management issues in automotive electronics. Potential gains include superior thermal conductivity, controllable CTE, high strength, and lower cost. Emerging new materials will broaden the design options for many electronic devices, helping automotive electronics makers achieve new levels of physical and electrical performance.

Martin Stephan, an automotive electronics application and technical service engineer for Dow Corning, wrote this article for *AEI*.