FASTER PROCESSING OF SILICONE RUBBER

UV CURE TECHNOLOGY While silicone elastomers are normally vulcanized by heat or at room temperature by different crosslinking mechanisms, it has now been shown that they can also be vulcanized by exposure to UV light using a UV sensitive curing system. The advantage of the UV cure system versus conventional heat cure generally lies in their potential to put into effect faster processing times.

Silicone rubbers comprise a big area, where silicones have found their way into technical products within a wide range of applications in different market segments. The first products were introduced into the market more than 60 years ago. This was possible due to the unique properties of silicones (also known as polysiloxanes) based on their molecular structure with their typical silicon-oxygen backbone. The remaining valences of the silicon atom are saturated by hydrocarbon radicals (mainly methyl groups). Silicones and silicone rubbers exhibit outstanding properties such as: high temperature resistance (up to more than 200 °C), maintenance of elasticity even at low temperatures (down to less than -60 °C), low temperature-dependence of physical properties in general, good aging stability and weather resistance, physiological inertness. If necessary, these properties can be further improved by modifying the silicone polymers or by using special additives during compounding.

At the end of the 1970’s a new kind of silicone rubber had been introduced into the market, the so-called liquid silicone rubber (LSR). The LSR silicone polymers have a much lower viscosity compared to the raw material of the High Temperature Vulcanizing or Curing Rubbers (HTV or HCR). In contrast to HCR’s, which are normally processed and vulcanized by techniques known from the manufacturing of organic rubbers, a modified injection molding process is used for LSR’s, enabled by their lower viscosity as well as by their higher reactivity based on a platinum-catalysed hydrosilylation reaction. Over the past decade the demand for silicone materials (HCR, LSR and RTV) has grown steadily as the market shifted to use of silicone rubber instead of other organic materials largely due to the stringent bio-compatibility, food contact and higher heat requirements imposed upon these materials. Particularly the addition curing materials are used in medical or food contact and water applications (e.g. no peroxide residues, FDA and BfR conformity).

UV Curing HCR for Rubber Extrusion In October 2007, the first UV cure Liquid Silicone Rubber (LSR) for Injection Molding of big volume parts was presented to the global market. As a next step in the UV Cure product family, Momentive Performance Materials has developed a UV curable silicone elastomer that allows extrusion of silicone rubber at room temperature through UV radiation. The UV cure technology can provide energy savings and increased extrusion speed while maintaining the classic properties of silicone elastomers. The UV exposure time for the cure can be as short as 0.5 seconds, depending on the speed of the line and the UV intensity. As the cure is initiated through UV radiation, the speed of cure is independent of the diameter and the cross-section of the extruded tube or profile. This allows high-speed extrusion without the risk of under-curing. Since cure of UV curable silicone elastomers occurs at room temperature, this new technology also opens the potential for co-extrusion of silicones with other temperature sensitive materials such as polyolefin and thermoplastic elastomers which is not possible with traditional thermal cure silicone elastomers.

Several test runs and comparisons of thermal cure materials with UV cure materials of the new product line for extrusion processes have shown that the materials typically cure at a much higher speed for equivalence in mechanical properties, resistance to heat and other characteristics normally achieved with the traditional thermal systems. Additionally, the UV

Authors
Holger Albrecht, Global Marketing Manager Elastomers Consumer, Momentive Performance Materials, Leverkusen, holger.albrecht@momentive.com
Dr. Yi-Feng Wang, Global Marketing Manager Next Generation, Momentive Performance Materials, Waterford, yifeng.wang@momentive.com
Dr. Stephan Bosshammer, Technology Leader LSR, Momentive Performance Materials, Leverkusen, stephan.bosshammer@momentive.com

Extrusion Sketch (Thermal and UV Cure)
system can provide processing advantages of extrusion without heat and minimal shrinkage in the final part. In addition, the shapes of the extruded parts have shown an excellent dimensional stability in applications like thick round tubes and complicated profiles.

These materials are currently available as transparent and colored custom compounds providing potentially cost effective solutions to demanding extrusion applications in the consumer, industrial and healthcare industries.

**UV Curing LSR for Large Volume Parts**

When LSR was launched into the market, versions of peroxide curing systems were also introduced. But since that introduction, only the addition cure LSR’s were successful and they grew at an average rate of approximately 10 percent per annum. The success of the product line was primarily built on the excellent processability that is comparable to a standard plastic injection molding. The LSR/LIM process offers the molder a highly automated process and achieves the typical properties of heat cured silicone rubbers. A standard LSR for injection molding can be cured at around 180 to 200 °C for fast cycle times. However, for filling the molds of large volume parts with LSR the curing temperatures need to be reduced in order to be able to fill the molds completely and to eliminate air entrapments in the molded part. The reduced curing temperature resulted in slow curing of LSR and long molding cycles of large volume parts. Typical parts with large shot weights are insulators, cable joints, cable terminations or surge arrestors. For the production of these parts, a special pumping unit feeds the low viscosity LSR directly through a static mixer into a heated mold. Depending upon the total shot volume, the mold temperature while filling may be reduced to 80 °C. The scorch time of the LSR is prolonged so that flow lines and air entrapments can be reduced. When filling is completed the temperature should be increased to 95 to 120 °C for fast curing. This lower temperature molding process leads to long production cycles that are not cost effective.

With a UV curing LSR, several test runs have demonstrated the possibility to produce parts in much shorter cycles, without applying heat. Therefore the molders may have a much higher productivity with a reduced number of defects that are typically caused by air entrapments than with conventional addition cure LSR’s.

**COST-EFFICIENCY**

**Reduced Processing Times by UV Curing**

With UV curable silicone elastomers part geometries commonly produced by molding or extrusion processing can be cured at significantly reduced times compared to conventional systems in extrusion or molding. Therefore the UV cure technology can provide energy and cost savings while maintaining the classic properties of silicone elastomers.