Press Release

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REACH-compliant, Anhydride-free Material Delivers Warpage Control, Fine Filling Capability and High Throughput Processing

Pioneering Liquid Compression Molding Material from Henkel Advances Fan-In and Fan-Out Wafer-Level Packaging

Irvine, California – Henkel Corporation today announced the commercial availability of LOCTITE ECCOBOND LCM 1000AF, a breakthrough encapsulation material that leverages a unique anhydride-free resin platform to enable thorough protection, improved warpage control and fine gap filling for fan-in and fan-out wafer-level packages (FI WLPs, FO WLPs). LOCTITE ECCOBOND LCM 1000AF, which is REACH-compliant, has shown effective reliability-enhancing performance in internal evaluations of several wafer-level packaging configurations including FI WLPs, embedded wafer-level ball grid arrays (eWLBs), FO WLPs, and chip-on-wafer (CoW) encapsulation.

As chip integration and new packaging technologies gain steam to address the cost, form factor and functional realities of accelerated electronics miniaturization, FO WLP and FI WLP approaches are increasingly being adopted, particularly for applications such as data processors, mobile devices, consumer electronics, and radio-frequency communication chipsets. However, with thinner dies – some as thin as 50 µm or less –conventional anhydride-based molding materials may not meet today's challenging requirements.

Henkel's Global Market Segment Head for Semiconductor Packaging Materials, Ramachandran ("Ram") Trichur, explains that traditional liquid compression molding materials are built on anhydride resin systems with larger filler sizes, which can limit warpage control effectiveness in FO WLP processes and the ability to penetrate narrow gaps for trench filling with FI WLP techniques. "The powder-type fillers often used in older-generation standard wafer encapsulation systems have large particle sizes that range from 25 µm to an upper cut of 50 µm," he says, noting that some of the trenches between dies in FI WLP processes are as thin as 40 µm wide. "Standard encapsulants are challenged to thoroughly fill high-density structures and, during fan-out wafer-level processing, have also shown warpage of greater than 2.0 mm after molding, both factors that can impact long-term reliability and wafer

handling. Henkel's anhydride-free epoxy liquid compression molding material resolves these issues."

LOCTITE ECCOBOND LCM 1000AF is a solvent-free encapsulant that integrates exceptionally fine particle fillers (average 3 µm, upper cut 10 µm), enabling high-yield, ultra-low warpage, excellent flow properties for void-free fine-dimension filling, and fast in-mold cure times for improved UPH. In testing, LOCTITE ECCOBOND LCM 1000AF exhibited the following performance benefits:

- **Ultra-low Warpage of <1.0 mm** –When evaluated on an 8" wafer, Henkel's LCM resulted in extremely low wafer warpage of 0.66 mm after post-mold curing.
- **Void-free Fine Gap Filling** – Formulated with finer particles, LOCTITE ECCOBOND LCM 1000AF quickly penetrates narrow trenches between die (FI WLP process), and is able to fill a 40 µm x 400 µm trench with no voids.
- **High Throughput** – Lab evaluation confirmed the material's high throughput capability, with the Henkel LCM achieving an in-mold cure time of five minutes.

"The ultra-low warpage, improved handling, high throughput processing, thorough five- or six-side protection and void-free performance of our new LCM serve to dramatically enhance reliability and long-term device durability," Trichur says, underscoring the significance of the new material development. "However, we didn't stop there. At the same time, LOCTITE ECCOBOND 1000AF delivers these attributes in an anhydride-free formulation that complies with strict REACH standards and in keeping with Henkel's commitment to sustainability. Wafer-level packaging just took a huge leap forward."

For more information about LOCTITE ECCOBOND 1000AF or to request a sample, visit Henkel's semiconductor web resource, and complete the 'contact us' form.

About Henkel in North America

In North America, Henkel operates across its three business units: Adhesive Technologies, Beauty Care, and Laundry & Home Care. Its portfolio of well-known consumer and industrial brands includes Schwarzkopf® hair care, Dial® soaps, Right Guard® antiperspirants, Persil®, Purex® and all® laundry detergents, Snuggle® fabric softeners, as well as Loctite®, Technomelt® and Bonderite® adhesives. With sales of around 6 billion US dollars (5 billion euros) in 2018, North America accounts for 25 percent of the company's global sales. Henkel employs approximately 9,000 people across the U.S., Canada and Puerto Rico. For more information, please visit www.henkel-northamerica.com.

About Henkel

Henkel operates globally with a well-balanced and diversified portfolio. The company holds leading positions with its three business units in both industrial and consumer businesses thanks to strong

brands, innovations and technologies. Henkel Adhesive Technologies is the global leader in the adhesives market – across all industry segments worldwide. In its Laundry & Home Care and Beauty Care businesses, Henkel holds leading positions in many markets and categories around the world. Founded in 1876, Henkel looks back on more than 140 years of success. In 2018, Henkel reported sales of around 20 billion euros and adjusted operating profit of around 3.5 billion euros. Henkel employs around 53,000 people globally – a passionate and highly diverse team, united by a strong company culture, a common purpose to create sustainable value, and shared values. As a recognized leader in sustainability, Henkel holds top positions in many international indices and rankings. Henkel's preferred shares are listed in the German stock index DAX. For more information, please visit www.henkel.com.

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