New Chip Encapsulation Compounds

With consumers demanding ever more reliability and durability from their electronic devices, the enhancement of chip encapsulation compounds has become ever more paramount. Naturally, different types of products require different forms of chip packaging. Today, some manufacturers are aiming to fulfil these needs with a broad range of adhesives designed for application-specific uses, for example in the automotive or consumer segment, or even with solutions tailored to customer-specific requirements.

One consequence of the microelectronic revolution is the fact that nowadays semiconductor chips are used in nearly all devices that surround us – from digital watches, mobile phones and car radios to the sensitive controls of servo steering and washing machines. The hardware of such devices has to bear certain conditions so that they can be operated in a secure and reliable manner throughout the duration of their service lives. Small but decisive are the sensitive microchips, and different forms of packaging, i.e. protection methods, have been developed for them. In the so-called COB process (chip-on-board), the bare semiconductor chip is bonded to a printed circuit board and then electrically connected to the circuit with thin wires. It is necessary to encapsulate the chip in order to protect the wires and the fine structures on the chip. Only in this way can effective protection against mechanical stresses (vibration, temperature fluctuations) and environmental influences (humidity, corrosion) be guaranteed. Technically speaking, this protection is achieved by encapsulating the chip with a liquid resin matrix, such as an epoxy resin adhesive, which is cured afterwards (glob top).

The development of electronic components for high-reliability applications, such as safety-relevant controls in cars, has called for the continuous enhancement of chip packaging, with smaller sizes and lower costs becoming additional requirements. Delo has been a leading global manufacturer of chip encapsulation compounds in the chip card industry for many years and the know-how they have acquired is of great benefit in the development of new encapsulation compounds for electronic chips where high reliability and fast curing are essential requisites.

Encapsulation compounds for reliability in the automotive sector

The properties required of chip encapsulation compounds can vary greatly according to the type of final product being produced. Highest throughput rates and many load changes in bending tests must be achieved for smart card chips; temperature stabilities of up to 150°C are not really relevant. However, components for use in cars or demanding industrial plants must work reliably within a wide temperature range and must be resistant to high mechanical stresses as well as unaffected by the influence of many types of media. These specific needs are mainly met by acidic-anhydride-interlacing epoxies. Their properties make them highly suitable for the requirements of high-reliability applications:

Figure 1 – In practice, chip encapsulation compound expansion coefficients greater than 20 ppm/K lead to high failure at temperature changes, as high inner tensions are caused by the so-called thermal mismatch as illustrated by the lightning. Thermal mismatch can be minimised by a chip encapsulation compound with expansion coefficients of 20 ppm/K or lower.

Figure 2 – Various chip encapsulation applications can be found on printed circuit boards, such as those designed for the automotive sector. For example, a glob top is placed on a chip and a chip embedded in a frame is encapsulated.
Low expansion coefficients and high glass transition temperatures

The encapsulation of chip and bond wires on the printed circuit boards involves the connection of different materials that expand or contract to differing degrees upon temperature changes—a so-called thermal mismatch. This effect results in tensions inside the connection. They are heavily dependent on the CTE (Coefficient of Thermal Expansion) of the encapsulation compound. In order to keep these tensions as low as possible, it is necessary to adjust the CTE to the CTE of the other materials (silicon chip 4 ppm/K, gold wires 14 ppm/K, printed circuit boards 0–20 ppm/K). In practice, best results can be achieved with products with a CTE ≤ 20 ppm/K, as provided by Delo’s new Delo-Monopox GE acidic-anhydride-curing epoxies.

The glass transition temperature (TG) of a polymer indicates a temperature range in which properties such as Young modulus or CTE change significantly. Therefore, it is favourable for the reliability of chip encapsulation compounds if the TG lies above the upper temperature range of use in the application. Values of >150°C can be achieved with Delo-Monopox GE.

High resistance to temperature, media and corrosion

Polymers have an upper temperature resistance limit. However, material changes, such as embrittlements, can already occur within the temperature limits specified, resulting in high inner tensions and failures. Such embrittlements can be caused by the influence of media for example. However, it is also quite possible that the encapsulation compound swells or aggressive media diffuse to the chip to be protected and cause corrosion. This effect is further intensified if corrosive matters are separated from the encapsulation compound by a substance, such as water.

Due to their high degree of cross-linking, Delo-Monopox GE chip encapsulation compounds have excellent thermal and chemical resistance as well as a very low post-curing potential. As a result of their almost ideal property profile, acidic-anhydride-curing epoxies have been used as chip encapsulation compounds in high-reliability applications for many years. Of the encapsulation compounds with different chemical bases, only silicones have become economically important. However, due to their suppleness they can only provide limited mechanical protection.

With its new developments, Delo has managed to improve the proven standard of acidic-anhydride-curing epoxies by combining novel raw materials and developing an efficient product group for miscellaneous, individual requirements. Not only have they passed standard reliability tests (1000 cycles temperature shock test -40 / 150°C; 1000 h storage in 85°C/85% r. h. climate under consistent load; threefold flow through Lead-free soldering profile) they also provide excellent reliability values, especially on problem chips with unfavourable wire bond arrangements.

In practice, Delo-Monopox GE show very good temperature and media resistances, resulting from their especially high stability against these influences.

Figure 3 - Reliability tests on problem chips show that the required number of cycles in the temperature shock test is only achieved by high-filled products. However, these chip encapsulation compounds are difficult to process due to their very high filling degree. Delo-Monopox GE780 combines high reliability with good processing properties.

Figure 4 - The graphic illustrates the change of significant properties of Delo-Monopox GE under different storage conditions. The product is very stable—even after storage in hot gear oil.
Chip encapsulation optimised for consumer products

The majority of consumer products, such as toys, digital watches or similar, clearly have far fewer requirements than those designed for the automotive sector; the temperature range of use is lower, media influences play a lesser role, and service life is generally shorter. Economic success depends on the ability to produce high quantities at low cost. As such chip encapsulation compounds which cure as quickly as possible and, therefore, “inline”, are required. Delo has enhanced the UV-curing chip encapsulation compounds, which have been used in the smart card sector for a long time, and has tailored them to the requirements of the consumer sector. For this application area, chip encapsulation compounds with two different curing mechanisms are available: Delo-Katiobond GE are cationic, UV-curing products, whilst the Delo-Monopox GE used in this field are heat-curing products.

The compounds can be cured very quickly, either by UV-light (30s at 55 mW/cm² UVA intensity) or heat (5min at 130°C). As well as evidently being faster than other already established products in this field, these compounds also meet reliability requirements.

Customisation for technological progress

The enhancements and improvements of the standard products in this sector were introduced in order to meet the changing requirements of users. Delo can offer new, reliable and economically interesting solutions for many applications, including particularly problematic ones, with a wide state-of-the-art product range. But Delo goes a step further. User requirements vary to such a degree that, even with a wide range of standard products, it is possible that not every special case can be solved. The flexibility of the medium-sized company however allows for customer-specific modifications even for comparably small quantities, from as little as 25kg for example. This is why Delo is such a highly appreciated partner in the product development process of many well-known automobile manufacturers and component producers. The know-how and support of the adhesive manufacturer can be ideally combined with the ideas and visions of the electronic developers in order to further advance the micro-electronic revolution.

Stencil Cleaning At Low Temperatures

Vigon SC 400 is a water-based cleaning medium that utilises the unique patented MPC technology. Specially developed for cleaning at low temperatures, the medium is most effective between 15°C and 20°C and can therefore be used in all unheated spray-in-air and ultrasonic stencil cleaning systems to remove solder paste and SMT adhesive from stencils and misprinted boards.

Vigon SC 400 can be used in cleaning as well as rinsing stages, has an extremely long bath life, and can be easily filtered, which guarantees low bath maintenance. The product is also fully compliant with the new RoHS & WEEE guidelines, as well as all other Zestron cleaning agents. It is available in a concentrate as well as a ready to use mixture.

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