

Transparent and translucent casting resins for LED encapsulation

The potting of transparent or translucent casting resins for encapsulation of LEDs serves to protect these sensitive lighting elements against mechanical damage, moisture and other environmental influences. The specific requirements of the part determine the selection of the suitable potting system. The potting properties can be adapted to the specific application and part features, in particular hardness, density, temperature resistance, and processing parameters like viscosity, pot life, and tack-free time, which can vary over a broad range. Therefore, it is advisable to consider these factors already in the early design stage of LED lamps and LED light systems. For transparent potting Sonderhoff offers two-component reaction materials, the Fermadur systems on polyurethane (PU) or the Fermasil systems on silicone basis. These potting materials can be economically processed on full- or semi-automatic low pressure mixing and dosing machines, also in mass series without any variations in quality. It must be cast bubble-free into the cavity of the part, which is crucial for a solid encapsulation. Due to their excellent flow behaviour PU or silicone potting materials are homogeneously and fully distributed without air pockets also in most remote corners of complex part geometries. The automated application of resins by using mixing and dosing systems has become the standard process in the automotive, electronics, packaging, and lighting industry as well as in many other fields.

1. Introduction

Polyurethane and silicone casting resin systems from the sealing specialist Sonderhoff Chemicals GmbH have proven themselves in a huge range of casting applications over the years. With the so called two-component potting compounds electronic and electrical elements are protected against mechanical impact and various media. The processing

is generally done with semi- of fully automatic low pressure mixing and dosing machines. They are developed and constructed by Sonderhoff Engineering GmbH in Hörbranz, Austria.

The potting compounds are adjustable according to their application and the required properties, especially hardness, density, temperature resistance, and process properties like viscosity, pot life, and tack-free time

which widely vary. Different colours are possible. Transparent or translucent two-component potting compounds are used for transparent or optically attractive applications. In the area of lighting the encapsulation of LED elements with transparent or translucent (opaque) potting material is especially worth mentioning (fig. 1).

The light-emitting diode (LED) is a semiconductor element. If voltage is applied to the semiconductor diode, the energy of the electrical current is converted into luminous energy with a relatively low generation of heat. As LEDs only emit a very small ray of light, the individual LEDs are normally clustered together with several LEDs and connected into LED modules. While the luminous colour of the light diodes was still a problem in the beginning, a number of LED bulbs now produce pleasant light for the living area, which is considerably superior in its colour rendering to energy-saving light bulbs.

The advantages compared with traditional incandescent light bulbs: The LEDs use less energy emitting the same amount of light, generate less waste heat, are significantly smaller and insensitive towards vibrations, and also have a much longer lifespan. However, this depends on the used material for semiconductors and the operating conditions (heat, energy). LEDs shine brighter under high voltage and with it the temperature rises. This reduces their lifetime. The light-emitting diodes fade little by little, but do not fail abruptly as a rule. Their lifetime is

* Florian Kampf
f.kampf@sonderhoff.com
Teamleader Marketing/PR
Jonas Bernhof,
Technical Marketing
Sonderhoff Holding GmbH, Cologne, Germany

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Fig. 1:
LED lighting strip



considered to end when the light yield decreases below 70 % of its initial value.

Because the efficiency of light diodes has increased considerably in the last few years and the lifespan is significantly higher than that of traditional incandescent or energy-saving light bulbs, they are increasingly used in areas where low maintenance and reliability are important. LEDs can be found in a huge range of applications: LED bulbs as a replacement for neon tubes in moisture-proof lamps, LEDs in torches or traffic lights, in room or road lighting, as vehicle headlights, tail lamps, position lamps, and status displays.

LEDs are also increasingly being used to produce optical lighting effects, e. g. in illuminated furniture, display cabinets or frames, in which narrow and sometimes concealed LED strips provide pleasant indirect lighting and room ambiance. For this broad range of applications two-component potting solutions on the basis of polyurethane or silicone are frequently used for the protection of the LEDs (fig. 2).

2. Process reliable potting application

An optimal LED encapsulation potted with polyurethane or silicone protects against mechanical damage, moisture, and other environmental influences. Plastic covers or potting compounds can be used for it. Potting has the advantage that this material can be processed on fully automatic mixing and dosing machines very economically and with high process reliability. Essential for a solid encapsulation is that the potting compound is cast bubble-free in the cavities of the part for LEDs.

Due to their good flow rate the polyurethane- and silicone-based potting compounds even dispense into remote corners of complex parts, equally distributed and full-surface without entrapped air. Several LED series of diverse parts or shapes can be cast with the same potting product processed on a mixing and dosing machine.

The pre-setting and control of all machine and process parameters of the mixing and dosing system allows a fully automatic operation of the production procedure. LED lamps are encapsulated in a two-layer application process, first with a transparent protection layer and after curing in a second step covered with an opaque potting, which provides an optimal light dispersion. Both production layers are UV-resistant. Although LED light generates much less heat as traditional incandescent light bulbs, it is essential that protective encapsulations have a high temperature resistance. It is thereby possible to cover a wide range of different applications and operating conditions (fig. 3).

3. Great variety of casting systems, even under difficult operating conditions

The two-component potting systems from Sonderhoff fulfil the high demands placed on sealants by the industry, such as high density, mechanical stability and resistance to temperature, ageing and weathering. With these properties, electrical and electronic elements can be potted reliably. Temperature sensitive LEDs, relays, transformers, or sensors can be protected from moisture, dust, corrosion, and external mechanical, chemical, and thermal influences. The complete full-surface casting of LEDs with potting material on silicone or polyurethane basis is space and time saving. Easily scratched plastic coverings can be left out.

The impermeability of cast LEDs is considerably higher than that of transparent plastic coverings. Sealant grades of up to IP67 are achieved, so that external and underwater applications, e. g. swimming pool lighting, are possible depending on the component design. For tunnel lighting, the Fermadur casting systems from Sonderhoff are adjusted to be flame-retardant, so that they pass the inspection in accordance with UL 94 V-0. For explosion-proof lighting elements, e. g. for emergency lighting in explosion-prone underground surroundings, the casting resins can be formulated so that they pass the ATEX system inspection in accordance with ATEX Directive 94/9/EC (fig. 4).

4. Light transmission with LED clear casting

The type of selected sealant material plays a major role, especially for LED casting. This is because it can have a decisive influence on the properties of the emitted light. Sonderhoff offers in its product range Fermadur both translucent, opaque and coloured casting resins, which provide an optimal light dispersion and lighting hue, as well as transparent, crystal clear casting which does not influence the emitted light. This polyurethane-based optical casting is protected from yellowing caused by UV radiation by using aliphatic isocyanate and is also temperature stable up to approximately 130 °C.



Fig. 2: Passenger car LED tail light

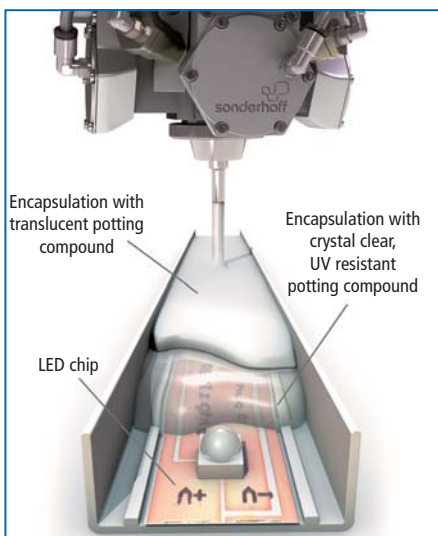
The light transmission of transparent or translucent casting compounds is vital to the lighting effect that can be created with LED lights. In optics, the transmission factor describes the proportion of occurring light flux, which penetrates the transparent material completely or the translucent material partially. Clear casting systems by Sonderhoff allow up to 89 % of the light to pass through. This transmission factor is identical to other

transparent plastics, such as PC, PS, and SAN. Only polyamide, PMMA and crown glass (optical glass) are still more translucent with values of more than 90 %.

Since the influences on light in addition to several other properties like hardness, temperature resistance or the so-called “self-healing effect” are important, a great variety of different material settings are necessary depending on the specific conditions of applications. The self-healing of potting material due to its flow rate properties is an additional advantage as thin scratches caused by mechanical impact degenerate opposite to plastic covers, i. e. the initial casting surface is back as before. Thus, the transparency and the light transmission of LED clear casting are maintained.

processed analogue to the two-component polyurethane potting material. Silicones even exceed the mechanical properties of polyurethane casting systems. For example, they have a very high crack and flexural resistance. This means, silicone-cast LED applications can also be effectively protected against moisture and weathering, even under extreme environmental conditions. These silicone systems, which are temperature stable up to 180 °C, are available crystal clear or opaque if required and do not yellow. Advantages: silicone potting saves space and time, because plastic covers with the disadvantage of becoming easily scratched are not needed and the processing step of single encapsulation of each LED light diode is omitted.

Fig. 3: Sonderhoff mixing head for the encapsulation of LEDs



5. Transparent potting compounds on silicone basis

Silicones are also very suitable for a potting compound for LED applications. Given the characteristics of the silicones concerned here the two-component systems from the Sonderhoff product family Fermasil can be

6. Conclusion

Sensitive LED lighting elements afford protection against damaging influences, currently most effectively done by LED potting. Which potting system is used depends on the specific requirements of the part to be cast. Therefore, the type, shape, and properties of a casting material should ideally be taken into consideration at an early stage when designing LED lights and lighting systems. Reactive material is available based on polyurethane and silicone for potting. It is processed by fully automatic low pressure mixing and dosing machines, which are optimally designed for this special task. Large series can be produced without variations in quality, fast and effective as well as efficient and economical. The automated application of casting resins using mixing and dosing systems has become the standard procedure in the automobile, electronic, packaging, and lighting industry and in many other fields.



Fig. 4: LED tunnel lighting

