



Electronic Grade Coating: an effective, efficient tropicalisation process for automotive electronics

The combination of the electronic grade coating technique with MEG's plant technology has proved effective for coating electronic components intended for the automotive sector.

Car electronic devices are fundamental and, at the same time, ever-expanding components. Automotive electronics manages multiple aspects, including as follows:

- it determines performance, fuel consumption, and the overall efficiency of the vehicles' operation;
- it reduces road accidents by optimising braking, road holding, and headlight illumination and compensating for the drivers' errors and distractions;
- it guarantees the safety of passengers by protecting them in the event of an accident;
- it optimises the driving experience through driver assistance, entertainment, and comfort systems;
- it protects the environment by contributing to the reduction of harmful emissions.

Looking to the future, the technological evolution of the automotive industry is increasingly ambitious, moving towards fully electrified

engines and self-driving cars. In this field, as in many other high-technology sectors (military, aerospace, medical, nautical, railway, telecommunications, industrial control, automation, etc.), the reliability of electronic components is therefore of the essence. Modern companies can no longer afford the economic and image damage resulting from any malfunctioning or premature obsolescence of their products, all the more so when these might affect people's health or lives.

It is therefore necessary that electronic devices and sensors are able to withstand any usage and environmental condition to which they may be exposed on a daily basis, including the most adverse and unfavourable ones. Vibrations, dust, humidity, vapours, corrosive agents or other chemical/physical contaminants, thermal and electrical fluctuations, and electromagnetic fields can seriously damage circuit boards and lead to serious malfunctions. At the same time, however, the manufacturers of electronic components must also find effective, efficient solutions to protect electronics without jeopardising business productivity and

The MEG's cleaning and electronic grade coating system installed at MEC s.r.l. Electronics Tomorrow.



significantly increasing process costs and/or any risks to operators and the environment.

The electronic grade coating (ECG) process

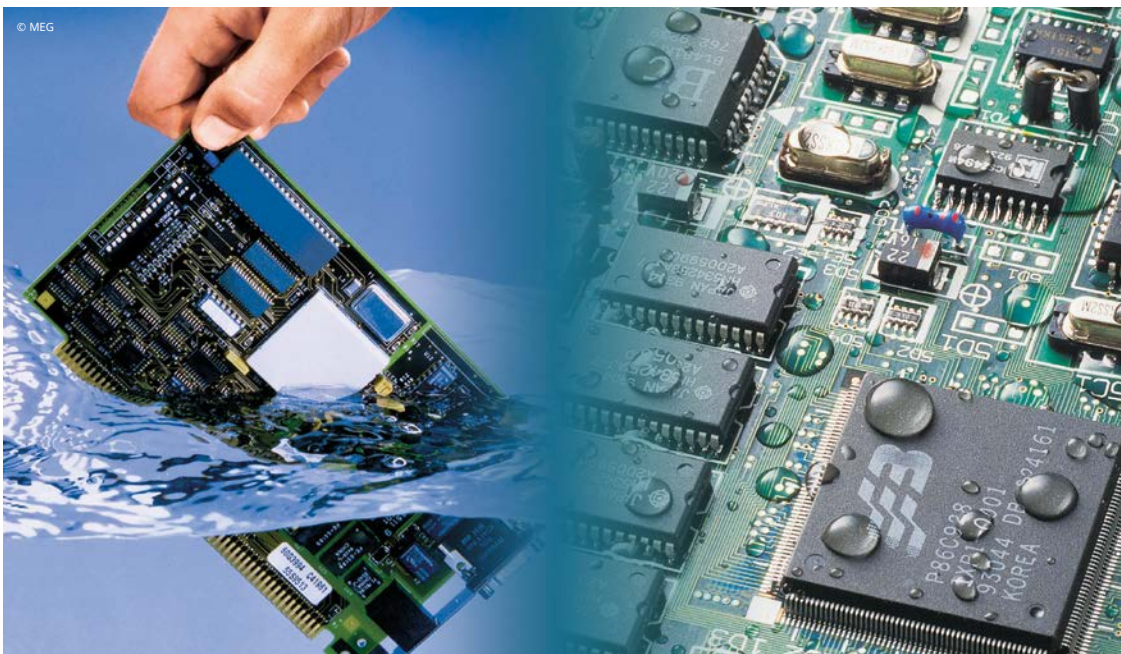
The response to all these market needs is the electronic grade coating process, which is a viable alternative to conventional conformal coating. It is a tropicalisation technique, already validated and approved by major players in the electronics industry, ensuring long-lasting performance, lower application costs, reduced production times and labour costs, improved quality, and greater safety for the environment and workers. Similarly to conformal coating, circuit boards are coated with a thin layer of synthetic resin that creates a barrier against external agents, thus improving electrical insulation and preventing dendrite growth and oxide formation.

Electronic coatings applied with MEG technology

The 3M coating product, distributed by Chem Solutions (Novara, Italy) and applied with the technology developed by MEG (San Martino di Lupari, Padua, Italy) for its 1S series plants, guarantees indisputable advantages. First of all, this solution guarantees a reduction, if not zeroing,

of process times. The resin is applied by total or selective immersion of the circuit board, with no need for prior masking (which is only necessary in rare cases) and its polymerisation is very rapid. This allows moving from cycle times of several minutes for the application of acrylic or silicone resins – and, in many cases, several tens of minutes, depending on the conformal coating product used – to a cycle time of just one minute for the application and polymerisation of the 3M product.

This is made possible by the formulation of 3M Novec™ ECG, which contains a latest-generation solvent that is non-flammable, non-toxic, and ODP-free and has a low surface tension value. This solvent does not require any heat treatment to dry, but only a rapid passage of the treated board through the cold coils of the automatic MEG machine, which even allows it to be recovered and reused through condensation. In essence, the use of tunnel ovens for cross-linking the resin is avoided and the dispersion of hazardous solvents into the working environment and the atmosphere is significantly reduced, as is the case with some conformal coating products that still contain substances such as benzene, toluene, ethylbenzene, and xylene.



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CHARACTERISTIC	EPOXY	SILICONE	URETHANE	ACRYLIC	PARYLENE	EGC-1700
THICKNESS (µm)	50 - 125	125 - 260	75 - 150	75 - 150	15 - 30	1
REWORKABILITY	Poor	Fair	Fair	Good	Poor	Excellent
MASKING	Yes	Yes	Yes	Yes	Yes	Not always
COVERAGE	Poor	Poor	Fair	Fair	Excellent	Excellent
PROCESS TIME (min)	<10 - 120	60 - 240	30 - 200	15 - 60	45 - 120	<5
DIELECTRIC CONSTANT (1MHz)	3.3 - 4.0	2.6	4.2 - 5.2	4.0 - 5.5	2.8	2.1
CHEMICAL RESISTANCE	Good	Excellent	Good	Poor	Excellent	Good
MECHANICAL DURABILITY	Excellent	Fair	Good	Good	Excellent	Poor
STRESS/CRACKING	Poor	Excellent	Fair	Poor	Excellent	Excellent

Source: 3M™

The advantages of this combined system

Compared with the spray application method normally used for acrylic and silicone resins, automatic immersion guarantees as follows:

- process repeatability;
- further reduction of cycle times due to faster handling;
- lower product consumption;
- better application of the product over the entire surface of the component to be treated, as it penetrates even below the surface thanks to 3M's low surface tension property.

In particular, immersion guarantees homogeneous coverage of the circuit board and it eliminates any shadow effect that can potentially be created when spraying in the presence of obstacles or different, large components, thus proving particularly suitable when treating miniaturised components.

The combination of MEG's application technology and 3M's properties also prevents the formation of air bubbles underneath the coating or their concentration on the edges of the treated board and, therefore, it guarantees the formation of a homogeneous film. In order to achieve these results, MEG's system has been designed to maintain constant level and temperature of the product in the immersion tank. This guarantees that the product can be continuously filtrated, with the consequent removal of any contamination, and stored in an integrated hermetic tank during its resting phase. A continuous control system for the concentration of the 3M resin is also being prototyped to ensure maximum yield at all times.

Integrating the two processes

A further advantage of the technology developed by MEG is the ability to integrate the coating application tank into a solvent cleaning machine, thus making it possible to combine and automate the two processes to the benefit of results and productivity. The selective immersion process also makes it possible to further reduce the consumption of the 3M product, which has a yield of approximately 34 m²/litre, equivalent to 23 m²/kg. In fact, once dried, the product leaves a 1µ transparent film on the circuit board, which has excellent hydrophobic, anti-adhesion, and anti-dust properties and which, thanks to its molecular structure, reduces the surface tension of silicone oils (**Table 1**). Application costs are therefore extremely low – they are estimated to be less than half or two-thirds of the alternatives on the market. Finally, the 3M product can be easily removed from the boards already treated with this process, thus allowing any repair or reworking operation.

Minimum thickness: one of 3M electronic coatings' strengths

A negative remark that is sometimes made about electronic grade coating concerns the thinness of its film compared with that created by other synthetic resins. Far from being a disadvantage in any way, this is actually one of the strengths of the 3M synthetic resin, as it does not affect its performance, nor does it affect the homogeneity and spread of the applied coating, but it rather results in product savings, short processing times, and easy removal for the rework of already-treated devices. ○