

Future-proof EM and RF shielding coatings based on sustainable technologies – latest developments from Spraylat and Pexa

Enclosures are one of the most important components of the hugely dynamic electronics and telecoms industries. Phones, hand-held bar code readers, in-car entertainment systems, cash machines, PCs and avionics are all devices which need to be housed in an enclosure, often with a screen and keypad. Advances in plastics technology mean that moulded plastics are the medium of choice for such products. However, unlike metal enclosures, these are usually transparent to Electromagnetic (EM) and Radio Frequency (RF) signals. This means that external sources of radiation can interfere with the equipment or that the equipment itself can interfere with other devices within close range.

Using metal containing conductive paints and coatings has become an industry wide solution, as a thin layer of a highly metal loaded paint will absorb EM and RF radiation while adding little in material costs or weight to the plastic component. As a result, moulded plastic can be substituted widely for metals in electronics and communications devices. Such coatings can be used for numerous other applications where electrical conductivity is required, such as for electrostatic discharge (ESD), SAR protection and lightning strike protection. Other applications include mobile phones, antennae, entertainment systems, test equipment, avionics and medical equipment.

The Spraylat Electronic Materials Group has been at the forefront of the development and production of these coatings and is now a world leader in the supply of shielding solutions. Pexa is Spraylat's distributor in the UK, Ireland and France, and has established the Spraylat product range as one of its most important product lines with a full array of stock plus technical and application support for its customers.

Composition

Spraylat's products use metallic pigments based either on copper with a fine coating of silver; silver itself or a hybrid mixture of the two, to offer a range of products which balance performance with cost per M². These formulations are referred to generically as "Copper" (silver coated copper), "Hybrid" (mixture of silver coated copper and silver) and "Silver" (silver only).

When asked to select the optimum coating for a particular application, a number of criteria have to be taken into account; these include component size, design and geometry, electrical performance requirements and substrate composition.

The principal driver for most specifiers is to achieve the desired technical result at the lowest cost. Copper products have the lowest cost per litre of product; as the silver content increases so does the cost of the material. Silver-based



Hand-held EDI 3G bar code reader – typical of the many devices that require shielding.

products deliver a very high level of performance at low thicknesses. Very often hybrid materials will provide the ideal balance of ease of application together with a low cost per M².

In addition to the conductive part of the product package, Spraylat uses advanced polymers to provide optimal film performance. Two of most important product ranges are:

Safe-on-Substrate 599B-series. These (SoS) products are based on mild, alcohol solvents which are compatible with most plastics without causing cracking or other damage associated with aggressive solvents.

599Z-series. These products are water based, offering similar properties to the SoS 599B-series but with the additional advantage of lower VOC emissions.

Variants of these products include removable, recyclable paints and special formulations for adhesion to difficult plastics such as ABS and polycarbonates.

A selection of products in the different categories is shown in *Figure 1* below, with their typical layer thicknesses required for optimal performance.

Film performance

The principal requirement for a paint is that it adheres properly to the substrate and provides a durable, cohesive film. Without this, none of the other more technical properties can be delivered.

Spraylat's coatings provide class leading performance in these respects, with superior adhesion to a wide variety of engineering plastics. Particle "pick-off" problems associated with earlier generations of conductive paints have been virtually eliminated and cross hatch adhesion results are readily met.

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Selection of Typical Products in Range		
Product Code	Composition	Typical Range of Film Thicknesses microns (μ)
Spraylat 599B Safe-on-Substrate Series		
599B3755	Copper	12.5-25.0
599B3740	Hybrid	7.5-17.5
599B3730	Silver	5.0-12.5
Spraylat 599Z Series		
559Z6261	Copper	12.5-37.5
599Z6103	Hybrid	12.5-25.0
599Z6098	Silver	12.5-15.0

Figure 1.

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In addition both durability and wear resistance are excellent. Where difficult plastics are used which can cause problems with paint adhesion, the product range includes special products designed to adhere to those substrates and optional adhesion promoters for very difficult cases.

Electrical performance

“Electrical performance” is the ability of the paint to perform as a conductor of electricity. Typical industry test methods to evaluate this performance include the Ohms (Ω) per square method, which allows a relatively simple measurement of the conductivity in Ohms at a given spot. Spraylat’s coatings range allows this to be tailored by selecting the required product to give the desired conductivity. Very high conductivity can be attained where needed. *Figure 2* is a graph showing the Ohms per square readings for a selection of products, this shows how the desired conductivity can be obtained by selecting the right coating.

In addition to Ohms per square, “point to point” testing is also used as a measure of coating continuity across areas including various

features and geometries. Point to point testing is often incorporated into OEM specifications to ensure electrical performance across critical areas in the enclosure design.

Figure 3 shows results for the three main types of coating tested on two differently configured mobile phone housings.

All these electrical results are obtained at low layer thicknesses especially compared with older generation conductive paints based on Nickel. This reduces the quantity and therefore the cost of the coating.

EMI shielding

Electromagnetic fields can interfere with equipment housed in non metallic enclosures and an important part of the design is to ensure that protection is provided. Spraylat’s coatings are highly effective and have the advantage that they are applied directly to the walls of the enclosure and do not need any extra support. The attenuation of the radiation across the paint film can be tested using various methods including the ASTM D4935-89 Co-Axial Transmission Line Test and Mil STD 285 Test.

Figure 4 (see page xx) shows a table of test results to the ASTM for the 3 main types of coating for frequencies up to 1.5 GHz, none of the coatings provides less than 70dB attenuation at any of the frequencies.

SAR protection

SAR (Specific Absorption Rate) is a measure of the radiation absorbed by the human body from devices. It is often used, for example, to measure radiation absorbed from mobile phones and MRI scans. SAR is calculated using

values for the strength of the electric field, the distance from the transmitter and the mass and conductivity of the affected tissue. International regulators such as CENELEC and the FCC have set limits for SAR from devices such as mobile phones. Conductive paints have been shown to provide excellent results when tested for SAR shielding performance.

Futureproof

Although the effectiveness of the technology is clear, product designers need to take account of the rapidly evolving regulatory framework, particularly in the areas of health, safety and the environment. It is important to select materials which are compliant with current and future regulations and which are formulated to be ahead of the needs of product users. Spraylat and Pexa are leading the way in developing and offering sustainable technologies.

REACH

REACH is the EU regulation 1907 of 2006, on the Registration, Evaluation, Authorisation and Restriction of Chemicals, this came into force in mid-2007. REACH identifies paints as “preparations” that comprise of a mixture of “substances”. The substances, which are the raw materials for the paint must be registered with the ECHA. Unregistered substances which are used in sufficient quantities will not be allowed to be put on the market within the EU. It is important for product designers to make sure that products they specify are composed of registered substances. In addition, the ECHA is identifying Substances of Very High Concern (SVHC).

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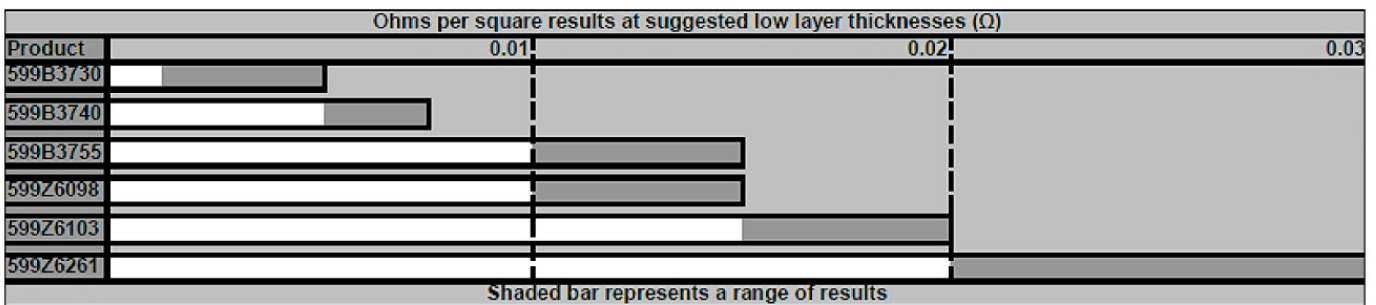


Figure 2.

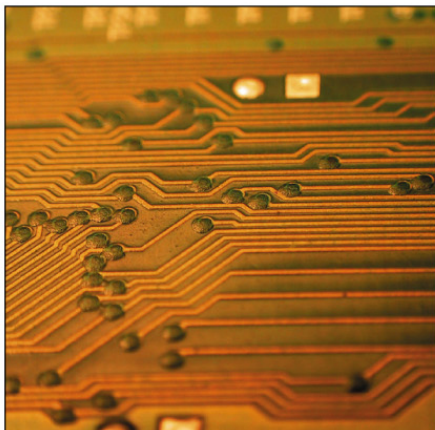
Point to point Spraylat 599B Safe-on-Substrate series representative results							
	Copper		Hybrid		Silver		milli-Ohms m Ω
	mid-distance	corner-corner	mid-distance	corner-corner	mid-distance	corner-corner	
Mobile phone housing 1	.180 to 0.200	.200 to .240	.090 to .110	.120 to .140	.080 to .100	.100 to .120	
Mobile phone housing 2	.100 to .130	.170 to .200	.110 to .130	.160 to .200	.100 to .120	.120 to .150	

Spraylat 599Z water based series offers similar performance

Figure 3.

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Electronics are vital to industry.

These substances are those where the safety risks of the substance in its intended application are considered to be significant. These substances will progressively be abandoned and products which include them will become unavailable. Pexa is committed to safeguarding its customers against risks to their continuity of production posed by REACH. Spraylat has ensured that all substances used in its products in the EU are adequately registered and that the list of SVHC is kept continuously under review; no currently identified SVHC are used in Spraylat's conductive products. REACH compliant safety data sheets are available for all Spraylat products.

EU SED

This is the EU directive 13 of 1999 which limits the emissions of organic solvents (VOCs) from industrial processes including painting. Critical measures within this legislation include the total amount of solvent used in a year, the concentration of solvents in exhaust emissions and the ratio between the amount of solvents and solids in the paints used. The simplest means of reducing emissions is to use products with reduced solvent content. Spraylat's water based products contain lower VOC contents than those found in conventional acrylic finishes used in similar applications.

This has an immediate impact on the total amount of solvent used and can help to bring a process out of regulation. It also reduces the emission concentrations and the weight of solvent used versus solid content. Product specifiers benefit from selecting water borne materials as production will remain feasible even under SED limits.

EMI Shielding Properties				
Co-Axial Transmission Line Test ASTM D4935-89				
Spraylat 599B Safe-on-Substrate Series results				
MhZ	Copper 20μ	Hybrid 15μ	Silver 17.5μ	dB
30	90	74	90	
50	88	74	92	
100	85	78	92	
300	78	73	78	
500	80	72	78	
700	79	72	78	
1000	78	71	86	
1500	77	71	86	
Testing to Mil Std 285 yields similar results				

Figure 4.

RoHS

RoHS is the EU directive 95 of 2002 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. It is linked to the WEEE directive (96 of 2002), which is the directive concerning waste electrical and electronic equipment.

The intent of these directives is to ensure that equipment does not contain above a certain level of hazardous materials, in order that the equipment can be recycled and to reduce toxic waste from end of life equipment. All the components of the equipment that can be identified as homogenous materials must meet the directive limits.

The substances which are restricted are:

- Lead
- Mercury
- Cadmium
- Hexavalent chromium
- Polybrominated biphenyls
- Polybrominated diphenyl ether

All of the Spraylat products mentioned in this article have been tested for the presence of these substances and in all cases they are at below detectable levels. This means that the Spraylat range can be considered RoHS compliant.

Metallic pigments

Traditional conductive coatings are often based on nickel. This is becoming less sustainable as paint manufacturers are finding nickel a difficult raw material to handle; particularly as a powder, which has significant risks in its handling. Global demand for nickel frequently significantly exceeds supply and this can put production at risk.

Spraylat has focussed on using copper and silver in its formulations, this represents a more viable alternative to nickel with improved visibility of supply.

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Snapshot selection of UL Certifications	
Product	Plastic substrate
599B3314	GE Plastics Cycloy variants
599B3314	Bayer Bayblend variants
599B3314	Asahi VA variants
599B3755	Mitsubishi Eng. MB variants
599B3755	Teijin Multilon
599Z6103	GE Lexan variants
599Z6103	Bayer FR variants

Figure 5.

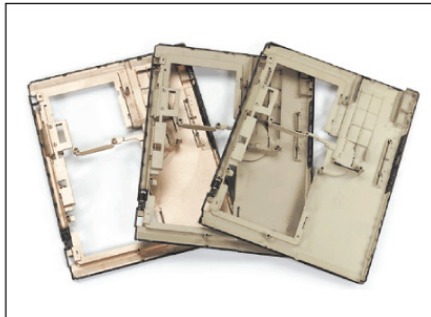
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Underwriter's Laboratory Approval

Underwriter's Laboratory (UL) is an independent product testing organisation, which offers more than 1000 standards for safety. UL certification is frequently required as part of product certification. UL is a US-based organisation and there are similar European organisations such as the VDE (in Germany); however, it is still the most frequent reference required for product safety and performance in the field of electronics enclosures.

UL certification extends to the combination of the coating together with the plastic substrate, therefore a coating on its own cannot have a UL certification. Many Spraylat



Control panels coated with Spraylat conductive coatings.

products have UL certification in combination with widely used plastics.

Figure 5 (page xx) shows a selection of some of Spraylat's UL certifications with some important plastics used in the electronics industry. Spraylat has a comprehensive list of UL certification and this is just a selection designed to indicate the type of combination that is possible.

What next?

The rapid advances in electronic communications are set to continue, we will become increasingly dependent on portable devices and our atmosphere will become more con-

gested with EM and RF signals. Spraylat and Pexa are committed to lead the way in the innovation of new solutions for these developing sectors. New products include paints which can be removed by washing off the equipment to enable recycling and reuse.

Spraylat has also developed paints for application to buildings to prevent EM from penetrating walls. This protects servers and other equipment from interference and can aid security in blocking wireless and mobile phone signals. Spraylat 'Z5' and 'Z9' products are already available for architects, builders and decorators to use in homes and public buildings and are of particular interest to people who wish to shield their homes from EM radiation from external sources.

The performance of a coated material is dependent on several factors beyond the coating manufacturer's control, the information herein provided is for general information only, and does not engage the responsibility of the manufacturer, distributor, writer, editor or publisher as to the final performance of the coated material.

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