# Boxing clever

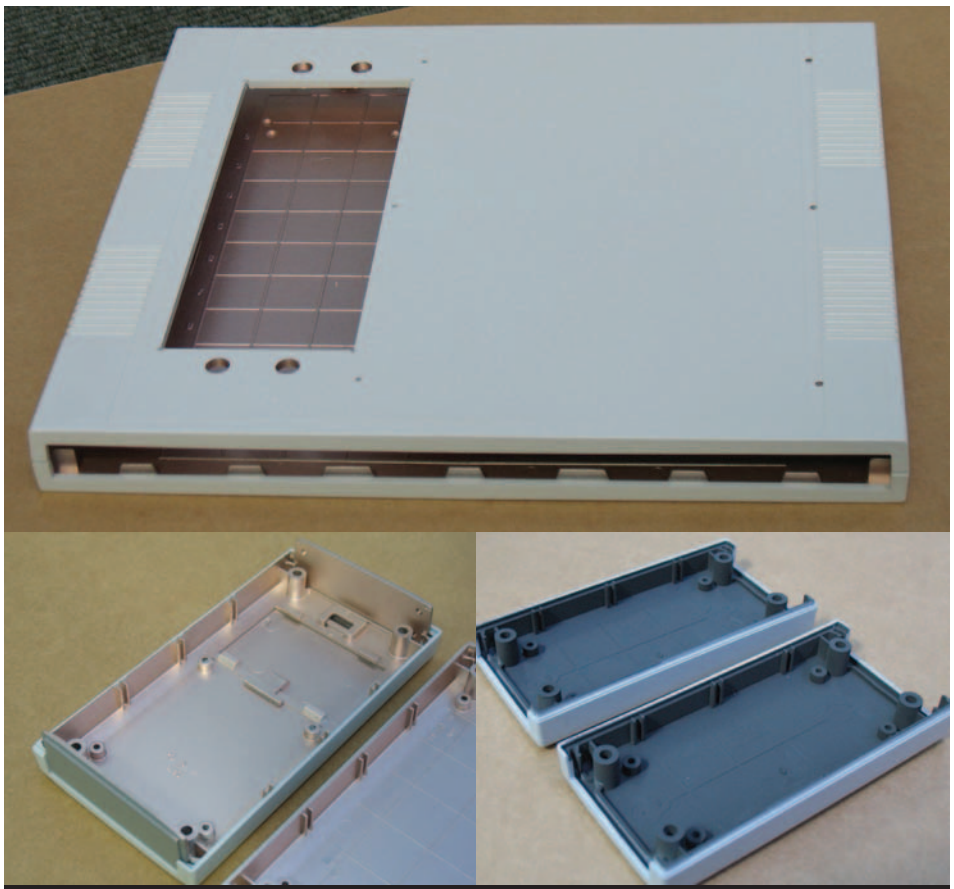
How the application of conductive coatings to the inside of plastic enclosures is broadening their application. By **Paul Hoath**.

Plastic enclosures have many benefits: many suppliers serve the market with a great number of standard products available in different styles and sizes at affordable prices, reducing time to market for new projects. The units are lightweight and allow complex shapes and features to be easily incorporated into the design. They can also be easily modified to accept displays, switches, connectors and other hardware.

However, moulded enclosures have one specific shortcoming: by virtue of the intrinsic properties of the material itself, plastic, unlike metal, offers no inherent attenuation to the passage of electric or magnetic fields. In many applications, this deficiency is of no consequence, but if radiation emitted by the housed electronics or their susceptibility to external fields is a potential problem, the lack of screening could be an issue.

Enclosure manufacturers have typically addressed this issue by adding conductive coatings to the inside of the enclosures, although some products are moulded from a conductive plastic. Whichever approach is used, and the coating method is by far the most popular, the design of the mouldings can have a significant impact on the screening effectiveness of the conductive coating.

Most plastic enclosures are constructed from a top and base moulding; in some designs, there may be battery compartments and removable end panels as well. One of the key requirements for effective screening is that the internal surface of the enclosure should be as continuous as possible to ensure electrical conductivity between all its parts. In particular, long slots should be avoided. To prevent slots between the mating halves of a typical enclosure, a tongue and groove structure forms an effective complex path, improving the attenuation performance. Obviously, the higher the frequency, the lower the wavelength, so even very small gaps can have a detrimental effect on EMC performance. If there are removable end panels, they need to be secured into an interference fit slot or, if they are secured using fixings, a conductive gasket should be fitted to the mating surface.



*Top: A Vero IBX enclosure with a copper finger gasket. Bottom left: A Veronex housing with a copper coating. Bottom right: A nickel coated Veronex enclosure*

The rear face of plastic panels will have to be conductively coated or, if aluminium panels are used, the front surface will normally be anodised and the rear left with a natural finish or iridised, a RoHS compliant conductive finish.

The best methods of providing suitable continuity in enclosures with dedicated battery compartments will depend on the design. If the battery box is constructed with solid partitions between it and the main internal space of the enclosure, the only precautions that need to be taken are to ensure the hole for the wires into the enclosure is as small as possible. If the battery is clipped into mouldings in the enclosure without a partition, then the lid of the battery box will form part of the overall screening and will be a potential weak spot in the screening – there will typically only be a flat surface

interface with the body of the enclosure itself.

Suppliers of conductive coatings have developed several different main materials for spraying the inside of enclosures to achieve different levels of attenuation versus cost. Vero Technologies has worked closely with its partners RF Solutions and Polymer Coatings to offer three coatings that will suit more than 95% of possible applications, with other coatings available for highly specialised uses. All three coating options are COSHH, RoHS and REACH Compliant.

Meeting general commercial level requirements, a nickel based colloid offers acceptable attenuation at a competitive cost. The 50$\mu$m thick film (see fig 1a) provides attenuation of up to 65dB at 50$\mu$m when tested to ASTM ES7-83, a standard test method for measuring the electromagnetic shielding effectiveness of planar materials. After temperature ageing of seven days at 29.4°C and 95% RH, there was no degradation of properties.

For more severe requirements, a copper colloid, formulated with silver coated copper particles and conductive resins, provides a conductive layer (see fig 1b) which is an effective shield against rfi and emi. It can also act as a ground plane to protect against esd.

As can be seen, its high frequency performance is better than that of nickel; but, given the relative costs of the base materials, the higher attenuation costs more. While not shown on the graph, the material has been tested to 10GHz to MIL STD 285, typically providing 78dB at 10GHz. After temperature ageing for days at 85°C at 85% RH and 10 cycles of temperature cycling of 75°C for 1hr, ambient for one hour and -30°C for one hour, and 56 days of high humidity testing at 35°C and 95% RH for 56 days, there was no degradation of the attenuation properties.

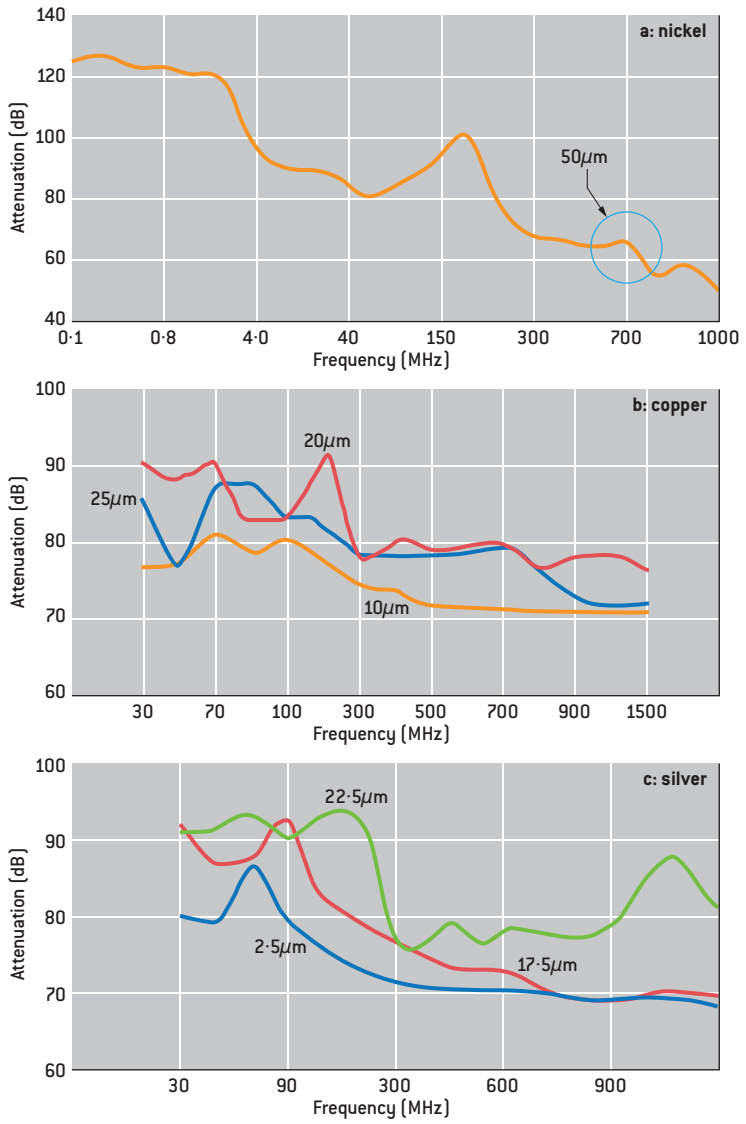
Striking the optimum balance between cost and performance, the copper colloid is Vero Technologies' default coating material.

The highest attenuation is achieved using a silver colloid, formed of silver flakes and conductive resins (see fig 1c). It provides an effective shield against rfi and emi and can act as a ground plane to protect against electrostatic discharge (esd).

The material was temperature aged for days at 85°C at 85% RH and 10 cycles of temperature cycling of 75°C for 1hr, ambient for one hour and -30°C for one hour, and 56 days of high humidity testing at 35°C and 95% RH for 56 days, there was no degradation of the attenuation properties.

Many applications require a display to be incorporated into the enclosure, normally viewed through a transparent window. Two main options are available to preserve the integrity of the internal conductive coating when a window is required. A wire mesh will provide continuity at the expense of clarity; the better option, originally developed for use on military helicopters, is a clear conductive coating that provides the required electrical conductivity without obscuring the display.

**Fig 1: Three coatings meet most enclosure shielding requirements**




### ESD protection

Electrostatic Discharge is a possible problem that can be minimised by the application of graphite or carbon based high conductivity coatings. ESD events can occur without a visible or audible spark at around 10V; sufficient to damage sensitive electronic components, causing outright failure or reduced long term reliability and performance reductions.

### External coatings

Several types of coating can be applied for specific applications. Whilst mutually exclusive, for medical use antibacteriological coatings inhibit the growth of e-coli, MRSA and other bacteria, while fire retardant low smoke coatings can be applied for aerospace applications, protective coatings that resist harmful substances found in petrochemical, pharmaceutical and similar industries are available, low friction coatings reduce surface wear and high visibility florescent, luminescent and iridescent coatings have benefits in safety critical applications.

Moulded enclosures are a popular choice of housing and, with the addition of high performance coatings to their internal and external surfaces, they also provide enhanced protection against damage to the housed electronics.

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