EMI shielding by means of CREASHIELD® vacuum coating technology

Some outstanding features of EMI shielding as carried out by the CREASHIELD process are:

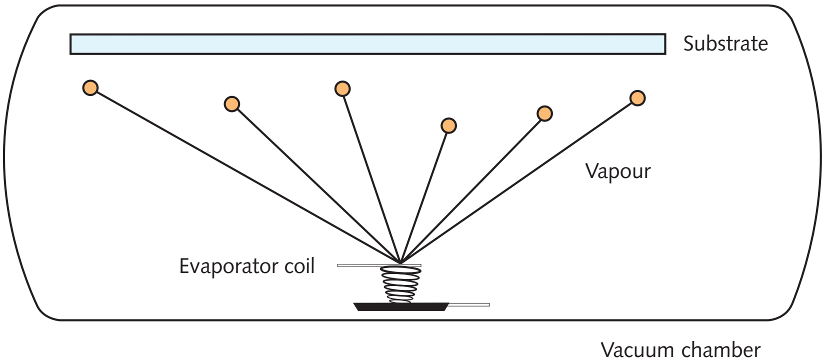
- Excellent shielding efficiency
- Straight forward and economical production process
- Minimal thermal influence
- Environmentally friendly

CREASHIELD shielding technology and the CREAMET equipment designed for this technology have all been developed by CREAVAC.

A. Introduction

PRINCIPLE

The application of metallic coatings for EMI shielding, in accordance with CREASHIELD technology, is carried out by means of the PVD (physical vapour deposition) process in a high vacuum environment by using of thermal evaporation equipment. Thus the material to be applied is heated and transferred in the gas phase. As a result of condensation, the evaporated material is deposit onto the substrate. Depending on which procedure is used, single as well as multiple layers can be applied. The applied coating thicknesses are generally, for this application, about 2 μm but can be greater in accordance with specific requirements.



CHARACTERISTICS

Coating materials:

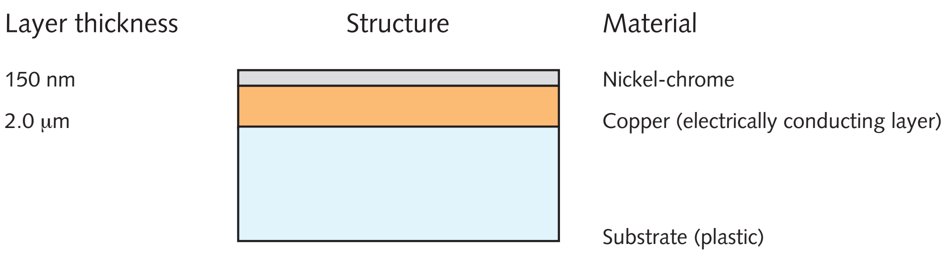
- Metals (copper, aluminium, gold, silver, tin etc.)
- Alloys (nickel-chrome, etc.)
- Reactive process possible (SiO_2)

Substrate materials:

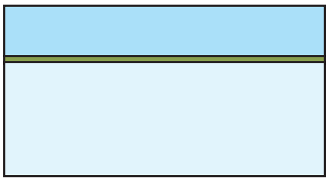
- Plastics (ABS, PC, ABS/PC, PBT, PA, etc.)
- Metals and glass

Coating:

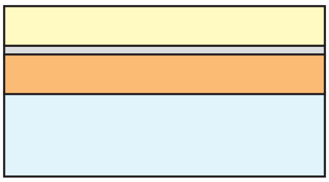
- EMI application: Variant A (CREASHIELD Cu process)



- EMI application: Variant B (CREASHIELD Al process)

Layer thickness	Structure	Material
1.5 – 5.0 µm		Aluminium (electrically conducting layer)
50 – 100 nm		Priming
		Substrate (plastic)

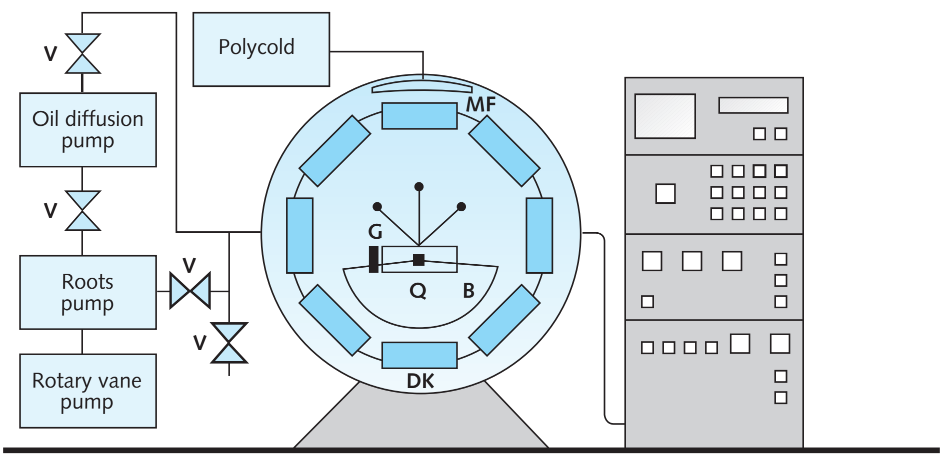
- Solderable shielding (CREASHIELD solder process)

Layer thickness	Structure	Material
1.5 – 3.0 µm		Tin
150 nm		Nickel-chrome (optional)
2.0 µm		Copper (electrically conducting layer)
		Substrate (plastic)

HIGH VACUUM COATING EQUIPMENT

- Pressure approx. 1 x 10^{-4} mbar
- Batching time approx. 30 mins

Pumping operation Vacuum chamber Control cabinet



B	Shutter	**G**	Glowing equipment	**Q**	Evaporator
DK	Rotary cage	**MF**	Meissner-Trap	**V**	Valve

Coating capacity (examples):

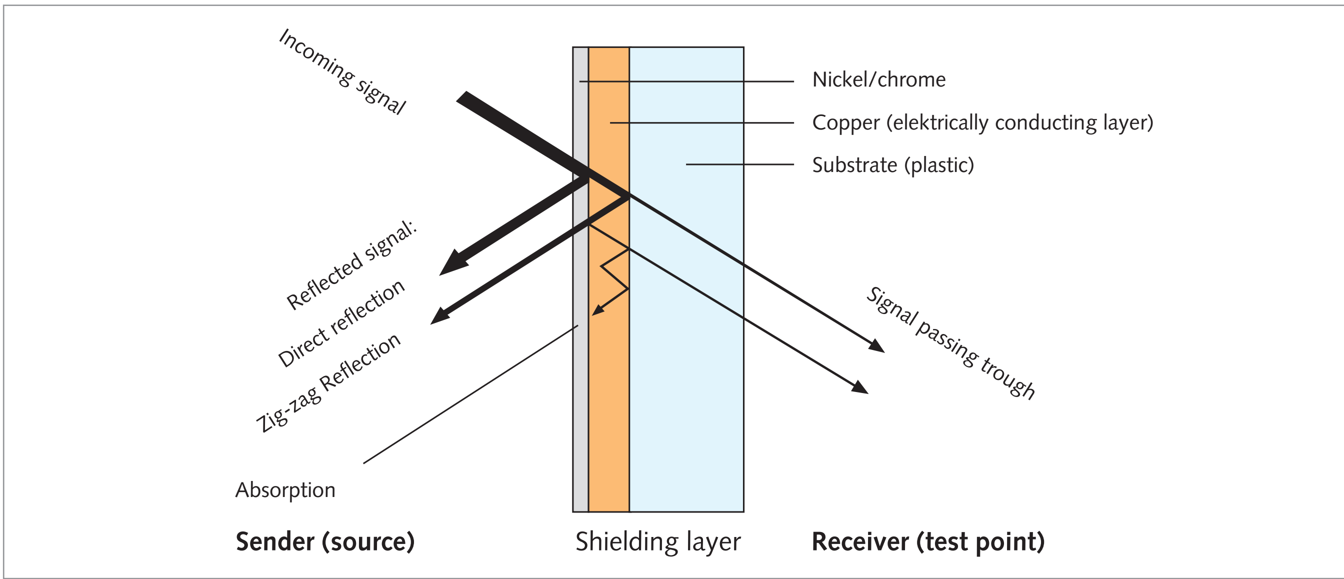
- CREAMET 1200 high vacuum coating equipment (chamber diameter 1,200 mm): approx. 1,500 parts per hour (100 mm x 45 mm mobile telephone housings)
- CREAMET rapid EMI high vacuum coating equipment (only for CREASHIELD Cu and CREASHIELD solder): approx. 3,000 parts per hour (100 mm x 45 mm mobile telephone housings)

PLASTICS DATA

Plastic		Maximum possible temperature [°C]		Coating behaviour		
		short period	long period	very good	good	problematic
ABS	Acrylnitril/Butadien/Styrol	95	85	x		
ABS/PC	Coplymere				x*	
ASA	Acrylnitril/Styrol/Acrylester	90	75	x		
COC	Cycloolefin-Copolymere				x	
EVA	Ethylvinylacetat	55	55			x
LCP	Liquid crystal polymere	200	130			x
PA-6	Polyamid 6	160	100	x		
PA-6.6	Polyamid 6.6	190	120	x		
PBT	Polybutylenterephthalat	165	100	x		
PC	Polycarbonat	150	130		x*	
PE/PP	Polyolefine					x
PEEK	Polyetheretherketon	240	240		x	
PEI	Polyetherimid	200	180	x		
PES	Polyarylethersulfon	190	190		x	
PET	Polyethylenterephthalat	200	100	x		
PI	Polyimid	350		x		
PMMA	Polymethylmetharylat	95	85		x*	
POM	Polyoxymethylen	130	100			x
PPA	Polyphtalamid	185	180		x*	
PPE	Polyphenylenether	120	100			x
PPS	Polyphenylensulfid	240	210	x		
PS	Polystyrol (Standard)	80	65	x		
PSU	Polysulfon	170	160	x		
PTFE	Polytetrafluorethylen	300	250			x
PU	Polyurethane				x	
PVC	Polyvinylchlorid	75	65		x	
SAN	Styrol/Acrylnitril	95	85	x		
SB	Styrol/Butadien	70	60	x		
s-PS	syndiotaktisches Polystyrol (Questra)	260	150	x		

*) with additional treatment

B. EMI theory



Because of the multitude of electronic equipment in our environment and the associated emission of electronic signals, it is important that, on the one hand, no disruptive signals enter an electronic device, and on the other hand, the sending out of a signal is minimal. For EMI (Electromagnetic Interference) the electronic tuning between the sender and the receiver of a signal will be syncronised without influencing the other component parts. There is built in sufficient immunity as also a reduced disruptive emitted signal.

An attenuation of electromagnetic signals is achieved by so-called shielding, or by a metallic coating, which is applied to the surface of the plastic housing. The shielding effect of this coating is based on the interaction with the electromagnetic signal, a part of the radiation is absorbed and a part is reflected (see diagram). Thus the electrical shielding is easier to manage than the magnetic shielding.

The shielding efficiency depends on the conductivity of the coating i.e. on the coating thickness and the specific conductivity of the coating material, on the housing geometry and additionally, in the case of shielding of magnetic fields, on the use of magnetic materials. It is dependent on the frequency. Thus, higher frequencies in the same coating thickness are, as a rule, absorbed more effectively.

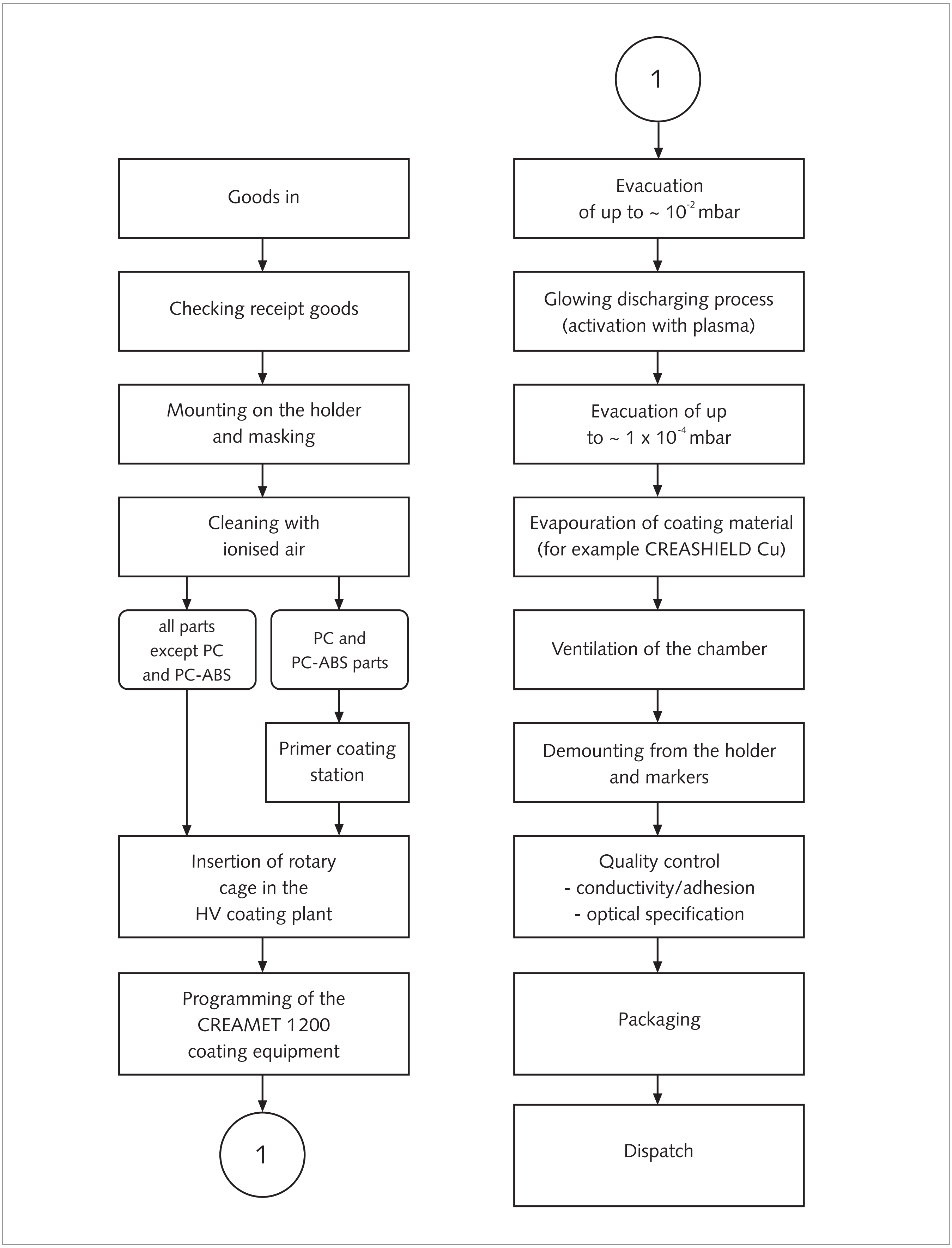
A shielding efficiency of 60 to 80 dB (good to very good) requires a coating resistance of between 400 and 20 mΩ (linear space interval of 100 mm).

Shielding efficiency of copper and aluminium (calculated):

Coating material	Specific electrical resistance µΩcm	Layer thickness µm	Layer resistance mΩ	Shielding efficiency	
				by frequency	dB
Copper	1.7	1.0	17	100 MHz	75
				1 GHz	81
Copper	1.7	2.0	8.5	100 MHz	82
				1 GHz	87
Aluminium	2.7	2.0	27	100 MHz	77
				1 GHz	83
Aluminium	2.7	3.5	13.5	100 MHz	82
				1 GHz	88

C. Process flow diagram

Production of EMI shielding using the CREAMET 1200 PVD high vacuum coating equipment, in accordance with the CREASHIELD process:



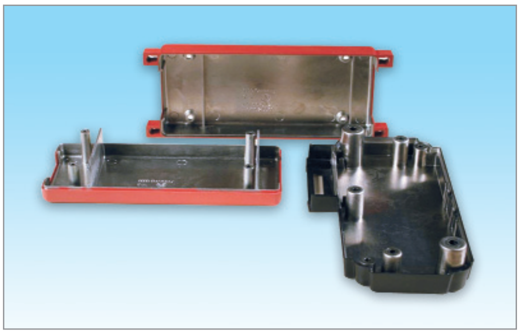
D. Quality parameters

Testing for	Test	Test requirements
Adhesion	Tape test, including temperature cycling test	in accordance with ASTM D3359-93 and UL746C
	Temperature and humidity test	60 °C and 95% relative humidity, duration: 1 week
Electrical resistance	Electrical resistance between 2 points	mostly < 0,5 Ω or < 1 Ω
	Layer resistance	< 30 mΩ

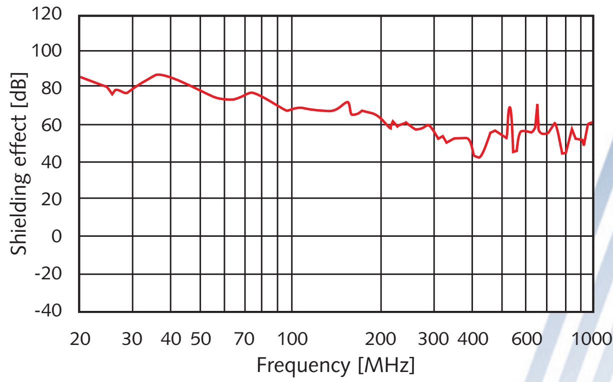
E. Comparison of various EMI coating technologies

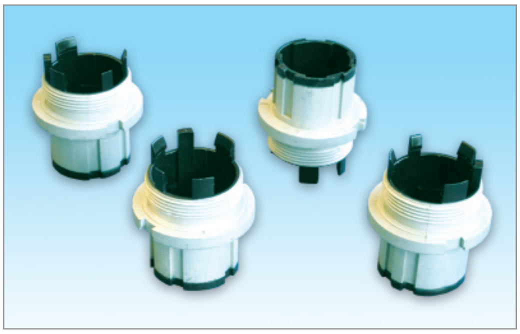
Technology	Substrate	Coating material	Thermal influence	Layer thickness	Shielding efficiency	Estimation
Thermal evaporation	Nearly all plastics	Metals and alloys	minimal	1.0 – 3.0 µm	good	- low cost - minimal thermal influence - ease of production - good shielding effect - no environmental problems
Sputtering	Nearly all plastics	Metals and alloys	high	< 1.0 µm	medium	- high cost - strong thermal influence - ease of production - medium shielding effect - no environmental problems
Plating	Limited choice	Limited choice	minimal	> 10 µm	good	- high cost - minimal thermal influence - ease of production - good shielding effect - necessary precautions for reduction of ecological damage
Conductive lacquer coating	Limited choice	Limited choice	minimal	> 10 µm	medium	- low cost - minimal thermal influence - ease of production - restricted reproducibility - medium shielding effect - necessary precautions for reduction of ecological damage
Metal cap	Nearly all plastics	Aluminium or zinc-plated iron		> 10 µm	good	- medium cost - no thermal influence - production is time consuming - only for simple designs - good shielding effect - necessary precautions for reduction of ecological damage

F. Examples of coatings



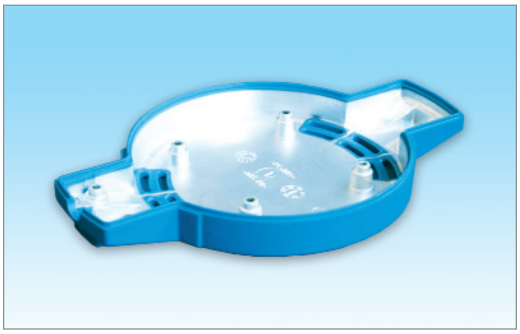
Copper, Nickel/chrome



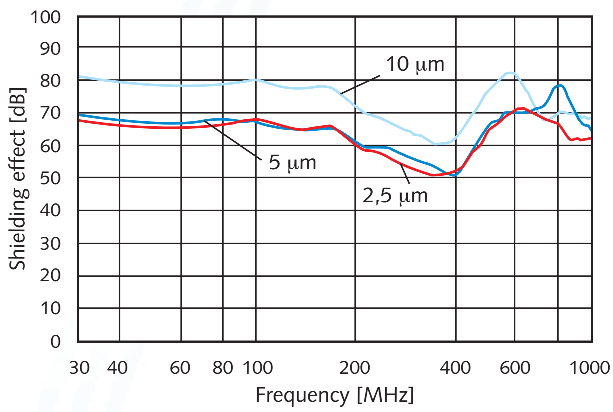


Copper, tin

Gold



Aluminium



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